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DENTIMACHUS HIMALAYAENSIS A NEW SCOLOBATINE SPECIES FROM INDIA (HYMENOPTERA : ICHNEUMOIDE)

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(Received 8 April 1985)

Dentimachus Heinrich is recorded for the first time from India by a new species *D. himalayansis*.

(Key words: Dentimachus himalayaensis, scolobatine ichneumonid, Hymenoptera, India)

The Scolobatine genus *Dentimachus* Heinrich is Palaearctic in distribution, hitherto known by its two Type species from Europe. Townes (1969) reports four undescribed species from CHINA and JAPAN. It is recorded here for the first time from Himalayan ranges in UTTAR PRADESH, INDIA by a new species, *D. himalayaensis*.

Dentimachus Heinrich

Dentimachus Heinrich, 1949—1986.

Type species: *Dentimachus morio* Heinrich. Original designation *Nemesoleius* Heinrich, 1949 : 87.

Type species: *Tryphon flavipes* Gravenhorst. Original designation.

Taxonomy : Townes, 1969. Part 3: 114.

The chief diagnostic features of the genus are clypeus moderately vide its Profile convex or rather flat with the apical part impressed or inflexed; mandible moderately long with its lower tooth longer than the upper tooth, notaulus absent, only weak impressions present; mesopleurum subpolished, with medium sized or rather small punctures, propodeum evenly convex except that the median apical area and sometimes the sublateral apical area are more or less defined by weak carinae, areolet present; nervulus distad of basal vein by about 0.18 to 0.2 its length; nervellus approximately vertical, intercepted at, below or sometimes a little above the middle; first tergite rather slender, lacking median dorsal carinae and evenly convex above, its dorsolateral carina absent basad of spiracle, present or absent distad; tergite 2 subpolished, its punctures small, hairs on female subgenital plate slanted backward.

Type species : *Dentimachus morio* Heinrich.

Its two known European species and the new species from Himalayas, India can be distinguished by the following key. Table 1 compares the distinguishing features of the three species.

Dentimachus himalayaensis sp. nov. (Fig. 1, a—d)

This species is distinct from the two European species known by the

TABLE 1. Comparison of the *Dentimachus* species known.

Sl. No.	Character	*morio*	*flavipes*	*himalayaensis*
1.	Clypeus	Black.	Apical depressed part in the middle reddish yellow.	Reddish cream.
2.	Face	Black.	Black.	Black with two kidney shaped marks laterally, creamish.
3.	Abdomen	Black.	Segments 1-4 reddish yellow, rest black.	Segments 3-5 red, rest black
4.	Fore and middle legs			
	a) Femora	Bright red.	Yellow red.	Black except reddish cream apically.
	b) Tibiae	Bright red.	Yellow.	Reddish cream.
	c) Tarsi	Bright red.	Yellow red.	Reddish cream except the apical segment black.
5.	Hind leg			
	a) Femur	Bright red.	Yellow red.	Black.
	b) Tibiae	Bright red, except apical 1/3rd black.	Yellow, except black at tip.	Black, except a stripe in basal 0.66 ventrally reddish cream.
6.	Nervellus	Intercepted at or below its middle.	Intercepted a little above its middle.	Intercepted a little above its middle.

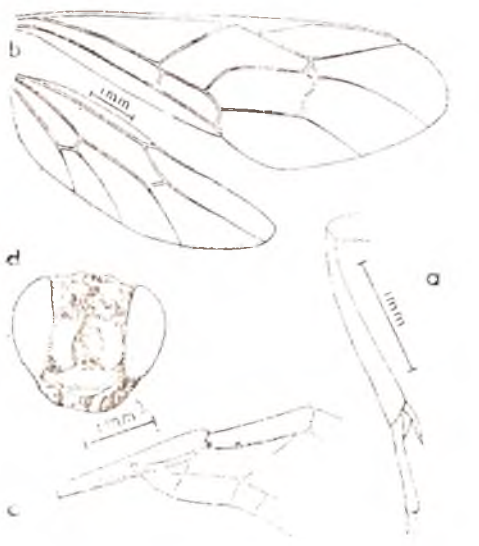

Fig. 1. *Dentimachus himalayaensis* sp. nov. a, fore leg; b, fore and hind wings; c, side view of abdominal tergites 1 and 2; d, front view of head showing colour pattern.

colour of its clypeus reddish cream, two kidney shaped marks on face; creamish, abdominal segments 3 to 5 red, all femora black except fore and middle apically reddish cream and hind tibia black except lighter dorsobasally and reddish cream stripe on its basal 0.66 ventrally.

Female: Head wider than long, 1.25 × as wide as long; face about 0.66× as long as wide, finely closely punctate, punctures separated by about the diameter width; clypeus 3.0 × as wide as long, its profile rather flat and its apical 0.33 inflexed at an angle with the basal part, finely sparsely punctate; polished, its apical margin sharp and straight; malar space 0.25× as long as the basal width of mandible; mandible moderately long, finely closely punctate, polished, its lower tooth a little longer and stouter than the upper tooth; labrum concealed; frons rather dull, finely closely rather inconspicuously punctate; ocelli close together, distad of eyes by 1.5× the distance between the lateral ocelli; eyes very weakly emarginated a little above the antennal sockets; scape ovoid, antenna 40 segmented and tapered to apex, its first segment 20× as long as the second and third about as long as the second; head sharply receding at back; temples and occiput moderately broad, polished and finely weakly punctate; occipital carina strong and complete, evenly round and joining oral carinae above the base of the mandible and placed rather low on the occiput, more or less equidistant from eyes and foramen magnum; thorax polished, finely closely punctate; pronotum at its lower hind corner, its anterior edge weakly carinate; epomia very weak and short; notauli impressions weak; scutellar carinae confined to its base; prepectal carina joining front edge of mesopleurum adjacent to a little below the middle of pronotum; speculum unpunctate; propodeum evenly convex, weakly punctate without carinae except at apex with short lateral longitudinal carinae; its spiracles subcircular; anterior tibiae at apex with a fine tooth, its spur 0.3× as long as its basitarsus, the membranous flap on its apex ending in an acute angle (Fig. 1—a), its last tarsal segment a little longer than its third (1.35 × as long as its third); hind inner tibial spur 0.5× as long as its basitarsus, its 5th tarsal segment about as long as its third; all claws simple evenly curved at tip; hind tarsus a little longer than its tibia (about 1.14 × as long as its tibia); wings clear hyaline with brownish tinge; nervulus (Fig. 1–b) vertical distad by 0.2 × its length; areolet petiolate; second recurrent interstitial with second intercubitus, with a bend in the centre towards inside, with two bullae: post-nervulus

intercepted at about its middle, stigma with radius arising distinctly before its middle; submedian cell with hair in its apical half; nervellus vertical, intercepted a little above its middle at about its upper 0.45; brachiella and discoidella almost upto wing margin; hamuli 7 to 8; abdomen polished, impunctete; first tergite (Fig. 1–c) slender with its spiracles placed at about 0.45 the distance from base; lacking median dorsal carinae; its dorsolateral carinae present in the apical 0.4, a little behind the spiracle, its ventrolateral carinae present fully, glymma present, its sternite extending upto its middle a liltle behind the spiracle, its length 1.5 × that of second; thyridium small; epipleura of tergites second and third separated by a crease, moderately wide and folded beneath: ovipositor about as long as the apical depth of abdomen, body covered with fine white pubescence, in abdomen distinct in only four basal segments.

Black. Flagellar segments fourteenth onwards lighter ventrally; face (Fig. 1 d) with two broad kidney shaped marks laterally creamish: clypeus, mandibles except at base and apex, fore and middle femora apically, their tibiae and tarsi except the last segment, hind tibia with a stripe ventrally in its basal 0.66 and all tibial spurs reddish cream; hind tibia lighter dorsobasally; abdominal segments three to five red; ovipositer sheath creamish at tip.

Length: ♀ 10 mm; fore wing 10 mm.

Holotype: ♀, INDIA : Uttar Pradesh, Chamoli district, Pandukeshwar, 1975 m; 15. ix. 1978, Raj Tilak (NRS, ZSI).

Distribution: INDIA : UTTAR PRADESH

KEY TO *DENTIMACHUS* SPECIES

1. Clypeus and abdomen completely black, all femora bright red, nervellus intercepted at or below its middle. Germany..... .... *morio* Heinrih

— Clypeus partly or fully reddish yellow or reddish cream, abdomen partly red; all femora yellow red or largely black; nervellus intercepted a little above its middle....2

2. Face fully black, clypeus only in the apical depressed part, reddish yellow; abdominal segments 1 to 4 reddish yellow; all femora yellow red; hind tibia yellow except black at tip. Germany..... *flavipes* Gravenhorst.

— Face black with two kindey shaped marks laterally creamish; clypeus raddish cream; abdominal segments 3–5 red; all femora largely black; hind tibia black except a stripe in basal 0.66 ventrally reddish cream and lighter dorso-basally. India..... ..... *himalayaensis* sp. nov.

Acknowledgements:—The author is grateful to the Director, Zoological Survey of India, and Dr. RAJ TILAK, Officer-in-Charge, N. R. S., Zoological Survey of India, for providing the necessary facilities to carry out this work.

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RELATIONSHIP BETWEEN STARCH CONTENT AND SUSCEPTIBILITY TO INSECT BORER IN THE BAMBOO REED, *OCHLANDRA TRAVANCORICA*[1]

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(Received 24 October 1985)

The relationship between starch content and susceptibility to the powder-post beetle, *Dinoderus minutus* in the bamboo reed, *Ochlandra travancorica* was studied in laboratory experiments by infesting reed samples of known starch content with 50 parent beetles and determining the number of progeny produced. The correlation was poor, with only 20% of the variation in the number of progeny being explained by variation in the starch content.

(Key words: Dinoderus minutus, Ochlandra travancorica, bamboo borer, starch content)

INTRODUCTION

Ochlandra travancorica Gamble, commonly known as read, is a small diameter bamboo used for the production of paper and rayon pulp. Like other bamboos, it is susceptible to attack by the powder-post beetles, *Dinoderus* spp., of which *D. minutus* Fabr. and *D. ocellaris* Steph. are the most important in Kerala (MATHEW, 198; NAIR, *et al.*, 1983). Previous investigations (NAIR, *et al.*, 1983) showed that in stored reed and reed products *Dinoderus* infestation is highly unpredictable. There was no clear-cut seasonal differences in susceptibility, although many authors have reported that bamboos cut at certain times of the year are less prone to infestation (GARDNER, 1945; JOSEPH, 1958; MATHUR, 1961). Among the factors which influence infestation, starch content of the bamboo is considered the most important, since it shows a strong correlation with the degree of susceptibility (BEESON & BHATIA, 1937; GARDNER, 1945; PLANK & HAGEMAN, 1951; JOSEPH, 1958; MATHUR, 1961). A critical study of the experimental data presented by various authors reveal, however, that the oft-quoted correlation between starch content and borer susceptibility is seldom based on quantitative studies employing adequate statistical methods of comparison. BEESON & BHATIA (1937) had clearly recognized the 'contradiction and inconsistencies' in their experimental data and concluded that starch content alone did not explain the variation in susceptibility, but most authors have been less critical in the interpretation of their data. In contrast to the general claim, VIADO & YLAGAN (1957) found no correlation between susceptibility to *D. minutus* and the starch or total sugar content of the bamboo, *Bambusa vulgaris*. The present study was carried out to throw further light on

1 KFRI Scientific Paper No. 86
2 Division of Wood Science
3 Division of Entomology

the relationship between starch content and borer infestations, using the bamboo reed, *O. travancorica* and laboratory-reared *D. minutus* (NAIR & MATAEW, 1984), under controlled conditions.

MATERIALS AND METHODS

Samples of the reed, *O. travancorica* were collected in May 1984 from Vazhachal Forest Division, where natural reed 'breaks' (stands) occurred. Culms, approximately 1, 3 and 5 year old as determined by their location within the clump and appearance, were selected. They were cut at the third visible internode from the base. Five samples were collected for each age group. The freshly harvested culms were dried at room temperature under forced air circulation for a period of two weeks. A 15 cm long segment obtained from each culm was used for the study. This segment was so selected as to include the fourth node of the standing culm, with the bottom cut at 3 cm below this node. The selected culm segment was then split longitudinally into two halves and one half used for estimation of starch content and the other for testing susceptibility to the insect.

Starch content was estimated according to the procedure described by MCCREADY *et al.* (1950). The samples were powdered in a Wiley Mill and the material passing through a 200-mesh sieve (B. S. S.) was used for the determination. The soluble sugars in the powder was removed by washing repeatedly with 80% ethanol and starch was extracted with 52% perchloric acid at 0°C. The resulting starch solution was then reacted with cold sulphuric acid-anthrone mixture. The intensity of colour developed was measured at 630 nm using photoelectric colorimeter. The standard reference curve was obtained using A R potato starch.

For testing susceptibility to the insect, *D. minutus* reared in the laboratory on dried tapioca (*Manihot esculenta*) tuber (NAIR & MATHEW, 1984) was used. The test sample obtained as described above was further cut into about 6–7 cm long and 1 cm wide splints and loosely stuffed inside a glass test tube, 14 cm ×2.5 cm. A group of 50 unsexed beetles were released into the tube and the tube plugged with cotton wool. There were three replicates for each age group of the reed culm. To serve as a standard for comparison, a similar set of tubes containing tapioca in place of reed, was included. Although five samples of reed were available for each age group, only three were used as the number of insects available was limited. The 600 beetles used for the experiment were collected from a tapioca culture, placed together and then separated into 12 groups of 50 each before allocating them randomly to the test samples. The tubes were maintained at room temperature (daily mean of about 30°C) at about 50 – 52% RH. The humidity was maintained by placing the tubes inside desiccators over a supersaturated solution of $Mg\ No_3.6H_2O$ (WINSTON & BATES, 1960). General observations were made at fortnightly intervals and at the end of 60 days, period sufficient for completion of one generation of the insect (NAIR & MATHEW, 1984), the samples were finally examined and the number of live adults and larvae counted.

The significance of the differences in the starch content and the number of insects produced was tested by one-way Anova. The correlation between starch content and the number of insects produced was also tested statistically.

RESULTS AND DISCUSSION

The starch content (Table 1) varied from about 3 to 10% in the various reed samples. There was wide variation within each age group, with no statistically significant difference between the age groups.

Sixty days after the samples were infested with 50 adult beetles, the population of insects (including live adults and older larvae) increased to a mean of about 68 in tapioca and decreased to a mean of about 28 in 5-year old culm, 15 in 3-year old culm and below 1 in 1-year old culm (Table 1). The number of off-spring produced in the standard diet of tapioca was lower than usual. About 5 to 10 fold increase in tapioca was common in earlier experiments (NAIR

TABLE 1. Starch content of reed samples and susceptibility to infestation by *Dinoderus minutus*.

Reed						
1-yr-old		3-yr-old		5-yr-old		Tapioca (standard)
Starch content (% dry wt)	No. of progeny in 60 d	Starch content (% dry wt)	No. of progeny in 60 d	Starch content (% dry wt)	No. of progency in 60 d	No. of progeny in 60 d
4.03	2	5.94	30(3)*	4.45	38 (9)	78 (20)
3.18	0	6.36	10	4.67	35 (5)	60 (10)
3.18	0	4.67	5	3.61	10	65 (10)
5.94	—	10.39	—	6.79	—	
4.45	—	3.82	—	7.00	—	
Avg. 4.16	0.7	6.2	15	5.30	27.7	67.7

*Figures in parentheses indicate the numbers of larvae out of the total shown.

& MATHEW, 1984). The comparatively lower rate of population increase in the present trial is probably attributable to the poorer physiological condition of the founding parents collected from a stock culture. No information was available on the age of the parent beetles. The lower multiplication rate, however, does not prevent comparison of the susceptibility of the different reed samples, because random groups from the same population of parents were used for all the samples. The results suggest a trend towards better survival (greater susceptibility) on 5-year-old culms, but very poor survival on 1-year-old culm, with 3-year-old culms falling in between. This apparent difference in susceptibility between different age groups of culms was not statistically significant difference, however. The prime objective of our experiments was not to test differences in susceptibility between different age groups, but between samples containing different levels of starch. Such a comparison is possible, ignoring the age of the culm. Table 2 shows the available data rearranged to show the relationship between starch content and susceptibility to infestation. The correlation between starch content and susceptibility to *D. minutus* infestation was poor ($r = 0.45$). Only 20% ($r^2 = 0.20$) of the variation in the number of insects was explained by variation in the starch content.

Our results are in agreement with the findings of VIADO & YLAGAN (1957), but contrary to that of several other authors, as referred to in the introduction. While a threshold level of starch content may be essential for survival of the insect, the starch content may not be directly related to the degree of susceptibility. That factors other than the presence of starch are in no way less important in determining the degree of susceptibility has been recognized (BEESON & BHATIA, 1937; SINGH, 1974; NAIR *et al* , 1983), but what those factors are and how they interact with one another and with the starch content, remain to be understood. The poor correlation

TABLE 2. Starch content of reed samples and the number of progeny *Dinoderus minutus* in 60 days

Starch content (% dry wt.)	No. of progeny
3.18	0
3.18	0
3.61	10
4.03	2
4.45	38
4.67	5
4.67	35
5.94	30
6.36	10

between starch content and susceptibility also explains the erratic results obtained with clump-curing (GARDNER, 1945; PLANK, 1950; MATHUR, 1958, 1961) aimed at preventing borer attack by reducing the starch content. The present study also shows that starch content of bamboo culms is not related to the age of the culm although flowered bamboos may show a drastic reduction in the starch content (SINGH, 1974).

Acknowledgements:—We thank Dr. S. KEDHARNATH, Director, for his interest in the study.

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EFFECT OF DIFFERENT INSECTICIDES ON THE CONTROL OF 'POLLU' BEETLE *LONGITARSUS NIGRIPENNIS* MOTS., A MAJOR PEST OF BLACK PEPPER *PIPER NIGRUM* L.[1]

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(Received 22 March 1985)

Fieled control trials conducted against 'pollu' beetle *Longitarsus nigripennis* Most. infesting black pepper *Piper nigrum* L. with three insecticides at Calicut and Kottayam districts and with seven insecticides at Calicut district, Kerala, revealed that endosulfan 0.05% and quinalphos 0.05% were more effective in controlling the pest damage on the berries, when sprayed twice a year during July and October

(Key words: black pepper, *Piper nigrum* L., 'pollu' beetle, *Longitarsus nigripennis* Mots., insecticidal control)

INTRODUCTION

The 'pollu' beetle *Longitarsus nigripennis* Mots. (Coleoptera : Chrysomelidae) is the most destructive pest of black pepper *Piper nigrum* L. in India. The pest is prevalent in most of the pepper growing tracts of Kerala and is reported to cause yield losses to the extent of 30–40 per cent (REHIMAN & NAMBIAR, 1967). The grubs of the pest are more injurious as they feed on the inner contents of tender berries rendering them hollow. The adult beetles scrape and feed on the tissues of the tender succulent stems, young spikes and tender leaves.

NAMBIAR & KURIEN (1962) recommended spraying of DDT 0.2% at monthly intervals from the last week of July or the first week of August for the control of the pest. REHIMAN & NAMBIAR (1967) found that DDT 0.2% sprayed twice a year, the first during July–August and the second 40 days later, was the most effective insecticide in controlling the pest. PILLAI & ABRAHAM (1974) reported that dimethoate 0.1% or qninalphos 0.1% or endosulfan 0.1% sprayed twice a year, during July and October, was effective in reducing the pest infestation. PREMKUMAR (1980) reported that endosulfan, quinalphos, methyl parathion, monocrotophos, methamidophos and isofenphos (0.05% each) were relatively more effective in controlling the pest infestation, when sprayed during June and September. A series of trials were undertaken during 1981–1984 in two agroclimatic conditions of Kerala to test the efficacy of different insecticides against the pest and the results are presented in this paper.

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MATERIALS AND METHODS

Two sets of trials were undertaken during the present study. In the first series, the comparative performance of three insecticides *viz.*, endosulfan, quinalphos and methyl parathion (0.05% each) in the control of 'pollu' beetle was evaluated at Koodathai (Calicut district) and Chempakkara (Kottayam district), which represented two different agroclimatic locations in Kerala. In the second set of trials the efficacy of seven insecticides, *viz.*, endosulfan, quinalphos, methyl parathion, monocrotophos, chlorpyriphos (0.05 each), carbaryl (0.1%) and fenvalerate (0-01%) was evaluated at Koothali (Calicut district).

The trials were laid out in a Randomised Block Design with a plot size of four pepper vines per treatment, each replicated five times in the first set of trials and four times in the second. The insecticides were sprayed with a rocker sprayer to run off level, twice a year during July and October. Twenty five spikes were selected at random from each of the vines at the time of harvest and the percentage of berries damaged by the pest under various treatments was determined. The trials were conducted for a period of three years consecutively and the data subjected to pooled analysis.

RESULTS AND DISCUSSION

The relative efficacy of three insecticides tested at two locations (Koodathai and Chempakkara) is presented in Table 1.

TABLE 1. Effect of three insecticides against 'pollu' beetle infestation in black pepper (combined analysis of three years' data of two locations).

Treatment	Mean percentage of damaged berries
Endosulfan 0.05%	1.53 (6.43)
Quinalphos 0.05%	1.86 (7.16)
Methyl parathion 0.05%	2.38 (8.36)
Control	6.24 (14.00)
C D at 1% level	1.28

Figures in parentheses are transformed values.

The percentage of berries damaged by the pest was significantly less in all treatments as compared to that in untreated control. Among the different treatments endosulfan was significantly superior to methyl parathion and was on par with quinalphos; plots treated with endosulfan had minimum percentage of damaged berries. Combined analysis for two locations and for three years indicated that the interactions of treatments × places and treatments × years were not significant.

The relative efficacy of seven insecticides tested at Koothali is presented in Table 2.

TABLE 2. Effect of seven insecticides against 'pollu' beetle infestation in black pepper (combined analysis of three years' data).

Treatment	Mean percentage of damaged berries
Endosulfan 0.05%	2.32 (7.74)
Quinalphos 0.05%	2.98 (8.37)
Methyl parathion 0.05%	4.08 (9.84)
Fenvalerate 0.01%	4.04 (10.07)
Carbaryl 0.1%	3.91 (10.36)
Monocrotophos 0.05%	4.31 (10.75)
Chlorpyriphos 0.05%	5.62 (12.20)
Control	9.51 (17.21)
C D at 1% level	3.36

Figures in parentheses are transformed values.

All the treatments were significantly effective in controlling the pest infestation on the berries, as compared to that in untreated control. Among the different treatments endosulfan and quinalphos were significantly superior to chlorpyriphos and were on par with the other insecticides. However, the plots

reated with endosulfan had minimum percentage of damaged berries.

The results of both the trials indicated that endosulfan 0.05% or quinalphos 0.05% can be recommended for the effective control of 'pollu' beetle infestation on black pepper. The present study confirms the earlier report of PILLAI & ABRAHAM (1974), who found that quinalphos 0.1% or endosulfan 0.1% can be used for the control of the pest infestation; however, in the present study both endosulfan and quinalphos were effective at lower concentration (0.05%). It also confirms the report af PREMKUMAR (1980) who found that endosulfan, quinalphos, monocrotophos and methyl parathion (0.05% each) were effective in controlling the pest infestation.

Acknowledgement: We are thankful to Dr. M K. NAIR, Joint Director, Central Plantation Crops Research Institute, Regional Station, Calicut for providing us with the necessary facilites for carrying out the above study and to Sri R. BALAKRISHNAN for statistical analysis of the data. Our thanks are also due to Sri THOMMY, Chempakkara and Sri THOMAS, Koodathai and the Farm Superintendent, District Agricultural Farm, Koothali for permitting us to undertake the trials in their plantations.

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STUDIES ON POPULATION DYNAMICS OF ORIENTAL RED MITE OF CITRUS, *EUTETRANYCHUS ORIENTALIS* (KLEIN)

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(Received 7 January 1985)

Oriental red mite *(Eutetranychus orientalis* Klein) population dynamics studies on *Coorg mandarin* at Central Horticultural Experiment Station, Chethalli, Kodagu, over three years (1981 to 1983) revealed that the mite was active from January 4th week to November 3rd week with two peaks of high population (May first week and September 3rd week) with 10 overlapping generations.

(Key words: oriental red mite, *Eutetranychus orientalis*, population dynamics, *Coorg mandarin)*

INTRODUCTION

Mites are major pests of citrus in many parts of citrus growing regions. The importance of some species in the *Tetranychidae* probably can be attributed to the use of broad-spectrum pesticides for the control of other pests (MCMURTRY, 1977). EDWIN DHARMARAJU & REDDY (1975) reported that the mites collect around the oil glands of the leaves and then suck sap. Consequently, small white spots occur around oil glands. Due to the presence of several small white spots on leaf and fruit, the surface turns pale green. Severely affected leaves and fruits drop off prematurely. These mites were present throughout the year. But they were more severe in summer months.

Since no information is available on the extent of population build up of this mite on citrus, an attempt has been made to study the population dynamics on *Coorg mandarin* at Kodagu under field conditions.

MATERIALS AND METHODS

Oriental red mite *(Eutetranychus orientalis* Klein) seasonal incidence and population dynamics was studied at Central Horticultural Experiment Station, Chethalli, Kodagu, Karnataka on 15 *Coorg mandarin* plants. These plants were randomly selected and tagged for observations. Observations were made at weekly interval from January 1981 to December 1983. Incidence of mite was recorded on 10 randomly selected medium matured leaves on each plant. Total number of nymphs and adult mites were counted and recorded on each leaf. The extent of mite infestation on *Coorg mandarin* was calculated by using the following three methods:

a) Per cent incidence : $\frac{\text{Sum of infested leaves}}{\text{Total number of leaves observed}} \times 100.$

b) Mite ineidence index : For computing this the leaves were graded on the presence of total number of nymphs and adults as follows:

Grde value	Number of mites per leaf (nymph + adult)
0	No mites
1	1—10
2	11—30
3	31—50
4	Above 50

$$\text{Mite incidence index} : \frac{\text{Frequency in each grade} \times \text{grade value}}{\text{Total number of leaves} \times \text{value of highest grade}} \times 100$$

c) Mean number of mites per leaf :

The number of nymphs and adults present on all 150 leaves were totalled and averaged per leaf.

Meteorological data for the entire period has been averaged and depicted in Fig. 2.

RESULTS

The results of the seasonal incidence studies of oriental red mite of citrus on *Coorg mandarin* for three years has been computed and depicted in Fig. 1. It is clear from these studies that the mite incidence on *Coorg mandarin* was recorded from January 4th week to November 3rd week and no incidence was recorded from November 4th week to January 3rd week during all the years.

Per cent incidence: The degree of infestation ranged from zero to 39.9 per cent. More than 10 per cent incidence was recorded during 13th to 19th week (March last week to May second week), 24th week (June 2nd week), 35th to 40th week (August last weak to October first week).

Mite incidence index: On an average the mite incidence index varied from 0

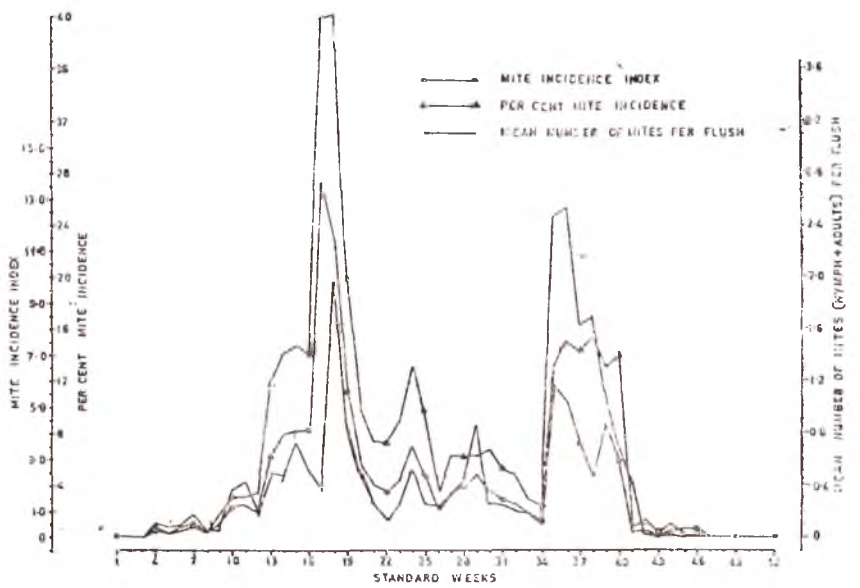

Fig. 1. Seasonal incidence of oriental red mite of citrus *Eutetranychus orientalis* on *Coorg mandarin*.

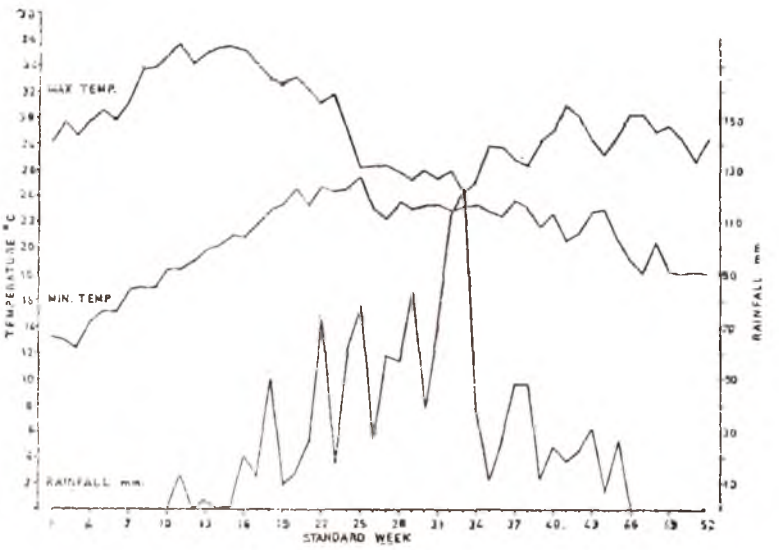

Fig. 2. Meteorological data.

to 13.6. High population of mite (incidence index was above 5.0) was recorded during 17th to 19th week (April last week to May 2nd week), 35th to 36th week (August last week to September fist week).

Mean number of mites per leaf: The average mean number of mites (nymph + adult) per leaf ranged from zero to 3.45 from January to November. More than 2 mites per leaf was recorded during 17th week (April last week), 35th to 36th week (August last week to September 1st week).

DISCUSSION

From the results it appears that there is not much difference observed in the peaks of high population of mites when the results were depicted as either per cent incidence or incidence index or mean number of mites per leaf. However per cent incidence figures cover a larger period of mite activity whereas the mean number of mites per leaf can show the exact week during which the highest mite population could develop on leaf.

A total number of 10 peaks (high and low) can be made out from the figure which otherwise indicates the number of generations of this mite on *Coorg mandarin*.

Since the earlier workers have not studied the seasonal population fluctuation of oriental red mite, it is not possible to discuss the results of present investigation. However EDWIN DHARMARAJU & REDDY (1975) and SADANA & KANTA (1972) mentioned that the mite damage was more apparent in summer. Spraying the *Coorg mandarin* plants during April first or second week can keep mite population at a very low level.

There is no correlation between mite population increase and temperature (low and high) or rainfall. But highest mite population developed at pre

monsoon period and the same was washed off during heavy showers and again when rains reduced little mite population develop during post monsoon period, from November 4th to January 3rd week.

Acknowledgements. The authors are grateful to the Director, Indian Institute of Horticultural Research, Bangalore for constant encouragement and facilities and to Mr. K.B. KARIAPPA and Miss. M. K. PADMAVATHY for their technical help in collecting the observations.

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TWO NEW SPECIES AND A NEW RECORD OF ERIOPHYID MITES (ERIOPHYIDAE : ACARI) FROM TAMIL NADU, INDIA

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The paper presents the descriptions of two new species of eriophyid mites, viz , *Calacarus malvavagrans* and *Colopodacus kallari* and the occurrence of *Aceria tulipae* (Keifer) in Tamil Nadu.

(Key words: India, eriophyid mites. new species, *Calacarus, Colopodacus, Aceria)*

During the study of eriophyid mites from Tamil Nadu two new species were encountered which are described here. The third species, *Aceria tulipae* (Keifer) is being recorded for the first time from this region. The types have been deposited in the Department of Entomology Collections, Tamil Nadu Agricultural University, Coimbatore - 641 003, India (TNAU)

Calacarus malvavagrans, sp. nov. (Fig. 1)

Females: Light pink in colour, with 5 wax bearing lines on the abdomen and wax coating on shield lines; 160* long, 55 wide, rostrum 20 long, pointing downwards, antapical seta 8 long. Shield 50 wide, 50 long with a pattern of wavy lines and cells; narrowing down posteriorly, median faintly represented by broken lines or absent; admedians clear, forming a ring like loop posteriorly wavy; submedians forming the cells along the border of the shield on either side; dorsal tubercles along shield margin on the sides, 35 apart; dorsal setae absent. Anteriorly the broad shield lobe overhangs the rostrum. Foreleg 25 long, tibia 6 long, tibial seta 5 long at about middle; tarsus 6 long; claw 6 long, curved and knobbed at tip; feather claw simple and 4 rayed. Hind leg 23 long, tibia 5 long, tarsus 5 long, claw 6 long. All usual leg setation present in the fore and hind legs. Coxae broadly joined, all three setiferous tubercles present, coxal area clear except for the clear sternal line. Coxal setae I and II in line, 8 and 20 long, seta III placed widely apart, 20 long. Abdomen with about 75 smooth tergites and about 90 finely microtuberculate sternites; lateral seta 22 long on ring 15; first ventral seta 50 long on ring 35; second ventral seta 28 long on ring 60; third ventral seta 22 long on ring 7 from behind; caudal seta 45 long; accessory seta absent. Female genitalia 27 wide, 15 long, coverflap smooth; genital seta 14 long.

Male: Unknown

Types: A holotype slide and two paratype slides, all with ♀♀; INDIA : NILGIRIS : Kallar, near fruit farm, 21. ix. 1984, ex *Kydia calycina*, Roxb. (Malvaceae) M. Mohanasundaram Coll. (No. 540) (TNAU).

* All measurememts are in μ m.

Remarks: This species resembles *Calacarus alocasiae* Keifer (1978) and *Calacarus brionesae* Keifer (1963) in the general shield pattern and 4 rayed feather claw but differentiated from them by the clear coxal area and smooth genital coverflap. It is also differentiated from *Calacarus carinatus* (Green 1890) by the 4 rayed feather claw; shield pattern and smooth genital coverflap.

Colopodacus kallari sp. nov. (Fig. 2)

Female: White, spindle shaped, 155 long, 60 wide, rostrum 12 long, antapical seta 4 long. Shield 55 wide, 32 long, with a pattern of faint lines; median represented as a short line in the rear end of shield; admedians wavy, complete, first submedian converging anteriorly, second and third submedians represented by short diagonal lines; sides of shield clear; dorsal tubercles just away from rear shield margin, 20 apart, dorsal seta 5 long pointing backwards and inwards. Foreleg 20 long, tibiotarsus 9 long with a faint delineation of the tibia; claw 5 long on the inner lateral angle; feather claw 4 rayed; hind leg 20 long, tibiotarsus 9 long, claw 7 long, tapering, straight and in dorsal position. Coxae broadly joined, with all three setiferous tubercles, slightly granular

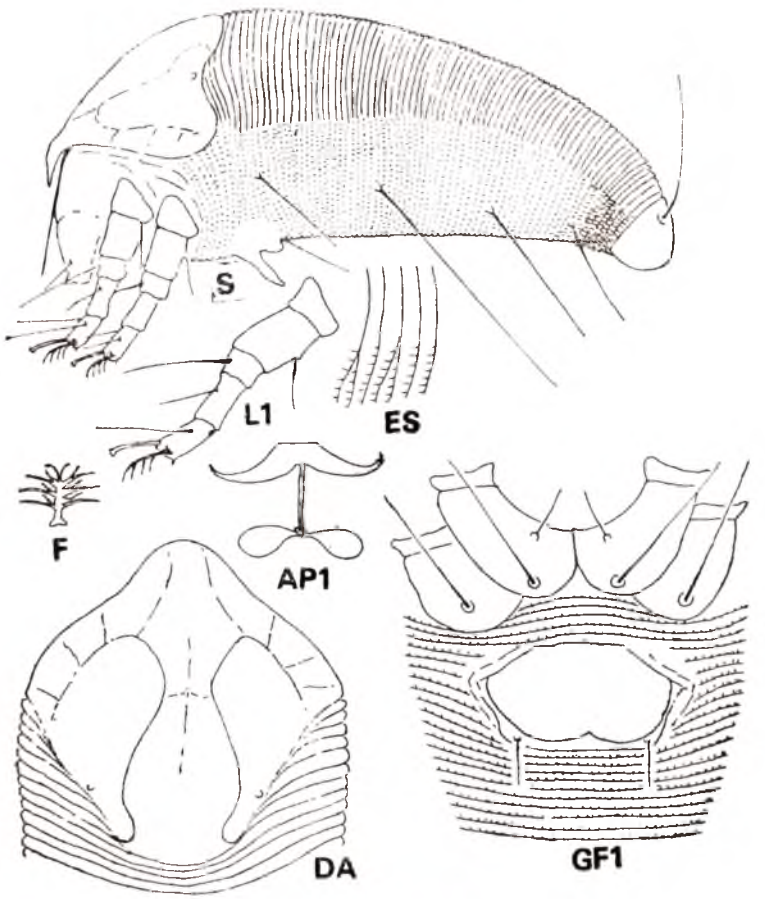

Fig. 1. *Calacarus malvavagrans*, sp. nov.

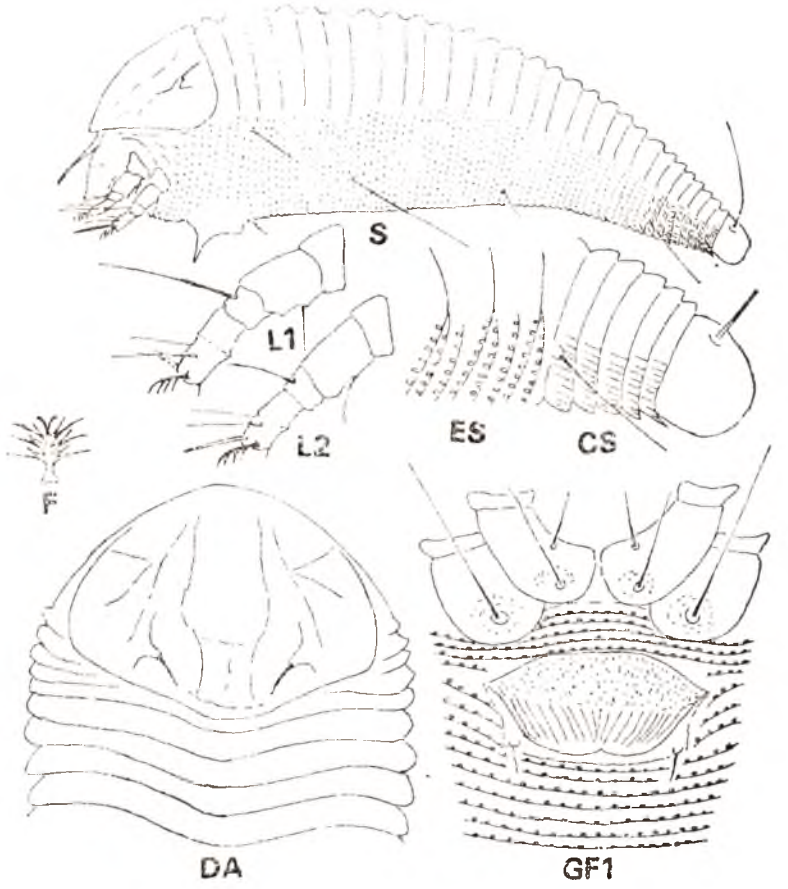

Fig. 2. *Colopodacus kallari* sp. nov.

ABBREVIATIONS USED

API—Female internal apodeme; CS—Side view of caudal end; CV—Ventral view of caudal end; DA—Dorsal view of anterior end; ES—Side skin structure, F—Feather claw; GFI—Genitalia of female and coxae from below; GM—Genitalia of male; LI—Foreleg; L2—Hindleg S—Side view of mite.

around tubercles II and III. Abdomen with about 28 broad smooth tergites and about 53–55 microtuberculate sterinites; lateral seta 20 long on ring 8; first ventral seta 30 long on ring 22; second ventral seta 5 long on ring 32; third ventral seta 18 long on ring 5 from behind; accessory seta absent. Female genitalia 27 wide, 15 long; coverflap with 18–20 lines distally and basally with fine scorings; genital seta 4 long.

Male: Unknown

Types: A holotype slide, and 8 paratype slides all with ♀♀: INDIA : NILGIRIS : Kallar, near fruit farm 21 ix 1984, ex *Cinnamomum wichtii* Meissn. (Lauraceae). M. Mohanasundaram Coll. (No. 539) (TNAU).

Remarks: The mites are under surface leaf vagrants causing no visible symptoms. This species is differentiated

from *C. africanus* Keifer (1960) by its shield pattern, 4 rayed feather claw; and scorings on the genital cover flap; from *C. glochidionis* Keifer (1969) by the smooth femora, shield pattern, and scorings on the genital cover flap; from *C. bengalensis* Mohanasundaram (1981) by the shield pattern, 4 rayed feather claw the genital cover flap with scorings; from *C. eugeniae* Mohanasundarum (1981) by the 4 rayed feather claw, small dorsal setae, and genital coverflap with scorings; from *C. gynalaxtae* Mohanasundaram (1981) in the 4 rayed feather claw, small sized female genitalia, and the shield pattern; from *C. walayarensis* Mohanasundaram (1981) by the shield pattern and scorings on the genital cover flap. It closely resembles *C. cinnamomae* Mohanasundaram (1981) in its 4 rayed feather claw, scorings on the genital cover flap but differentiated from it by the shield pattern, less granular coxal area and the shape of the microtubercles.

Aceria tulipae (Keifer 1938)

Material studied: TAMIL NADU : COIMBATORE, 18.xii.1984 ex. *Allium sativum* (Amaryllidaceae) garlic bulbs; Mohanasundaram Coll. (No. 542). The mites were found in large numbers on the shrivelled and drying bulbs within the white papery bulb cover.

Remarks: This species has been earlier recorded from Karnataka (Puttarudriah and Channabasavanna, 1958) causing damage to garlic plants. This is the first record of this mite from Tamil Nadu.

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EFFECT OF ETHYLMETHANESULPHONATE (EMS) ON THE SYNTHETIC ACTIVITY AND HISTOCHEMICAL PROFILE OF THE SILK GLAND OF *BOMBYX MORI*

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(Received 8 January 1985)

Ethylmethanesulphonate was intra-abdominally injected into the the early V instar larvae of the silk worm, *Bombyx mori*. The posterior silk glands were studied histochemically for the secretory activity of protein-carbohydrate complexes such as mucoproteins, acid mucopolysaccharides and neutral muccpolysaccharides for 24, 48 and 72 h postinjection. Alterations were observed neither in the acid mucopolysaccharide nor in the mucoprotein profile. Neutral mucopolysacharides however, increased after 24, 48 and 72 h postinjection of EMS followed by a decline in the secretory activity of silk.

(Key words: ethylmethanesulphonate, synthetic activity, silk gland, *Bombyx mori)*

INTRODUCTION

To date, information on the induced effects of chemicals as ethylmethanesulphonate (EMS), methylmethanesulphonate (MMS), acridine orange (AO) and mitomycin C (MC) on the tissue system are scanty, except for a few studies on rats (IBRAHIM *et al.*, 1970) and pigeons (SHAH & GADHIA, 1977) indicating induced alteration in the enzyme and glycogen levels of the liver, brain and muscle due to X-irradiation. Alternatively, a number of chemicals have been widely tested on seeds to obtain desired characters (MALLICK *et al.*, 1978) such as fruit quality, early flowering and high productivity in barley, wheat, rice and other crops. Evidence is also available of specific mutations for transmission of pathogens and vector capacity in the pest insects. The present work, therefore, was undertaken in order to extend further, studies on the effect of chemical (EMS) on the synthetic activity of the silk glands of the silkworm, *Bombyx mori*.

MATERIALS AND METHODS

Individual lots of the early fifth instar larvae (within 18—20 days after hatching) of *B. mori* (strain NB_4D_2, bivoltine) were intra-abdominally injected 0.025 ml of 0.01, 0.02 and 0.03% (in 0.85% sodium chloride) EMS with a hypodermic syringe. The injection of the chemical is followed by bleeding one or two drops of colourless blood and is soon interrupted. The larvae then start feeding mulberry leaves. The wound is healed after several hours never extending beyond 12 hours. However, the puncturing and wounding the abdomen of the larvae have no effect on the mucoplysaccharide profile of the silk glands.

Posterior silk glands of the larvae were dissected out and fixed in 10% buffered neutral formalin, absolute alcohol and Lillie's alcoholic lead nitrate after 24, 48 and 72 h postinjection. Ten per cent of the injected population of the silk worms were investigated for the study. Simultaneously, control individuals were injected successive doses of 0.85% sodium chloride and serial sections after specific hours were compared with the experimental groups.

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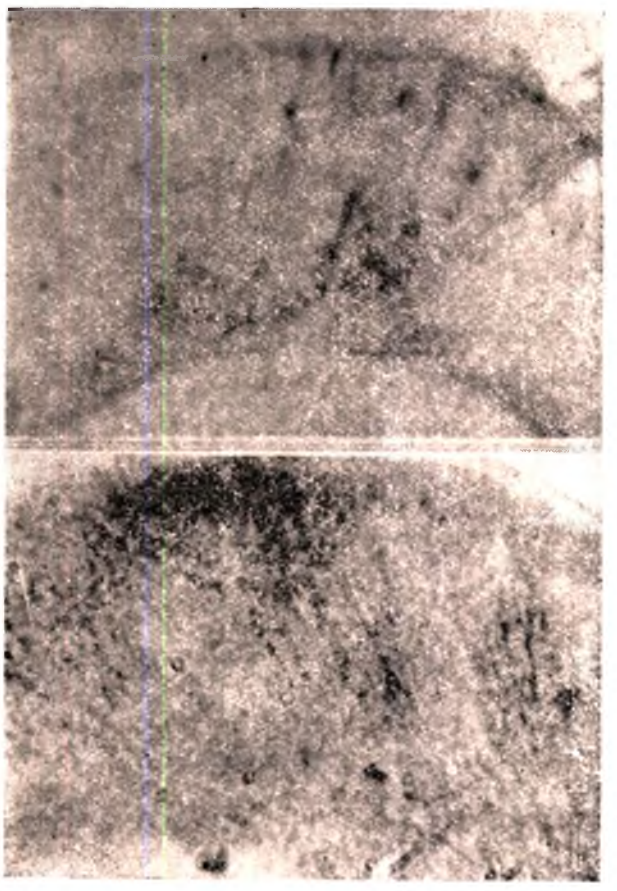
Paraffin sections were usually cut on a rotary microtome (Erma, Japan). Histochemical tests were done after PEARSE (1968).

RESULTS AND DISCUSSION

During the silk secretion and spinning various complexes of proteins and carbohydrates like mucopolysaccharides and mucoproteins were found to be associated with the silk in the silk glands of *B. mori* (NAYAK & PADHY, 1981). The type of specific complexes, however, vary from race to race. Synthetic activity of the above complexes begins in the early fifth instar larvae, continues till the end of the instar and then decreases after spinning. Therefore, this mature stage of the larva (five days) provided a convenient stage for the induction of the chemical to find out associated alterations in the synthetic activity and related histochemical profile.

Changes in the intensity of neutral mucopolysaccharides in the posterior silk glands due to induction of EMS were vividly noticed as indicated in Table 1. There were no changes as regards the mucoproteins and acid



Figs. 1–4. Histo-PAS profile indicating the neutral mucopoly-saccharide in posterior silk gland of *B. mori*. Fig. 1. PAS reaction 1+ in the normal; Fig. 2. PAS reaction 2+ in the normal.

TABLE 1. Shows the intensity of PAS positive neutral mucopolyaccharides in the posterior silk gland of the control and EMS injected lots of *B. mori*.

Reactions	control (h)	EMS dyes used	exptl. intensity	control intensity
Neutral	24	(0.01—0.03%)	6+	2+
mucopolysaccha-	48	,,	5+	1+
ride (PAS+)	72	,,	5+	1+
	24—72 h	(0.01—0.03%)	5to6+	1to 2+

+ indicates arbitrary units of intensity of the PAS reaction.

Fig. 3. PAS reaction 2+ in the EMS injected; Fig. 4. PAS reaction 6+ in the EMS injected sections.

mucopolysaccharides. As is clear from the table, the intensity of the PAS + substances varies between 1 to 2 + in the control (Figs. 1 & 2) and 5 to 6 + in the experimental sections (Figs. 3 & 4) in all the doses used. The larval period was also prolonged. There were associated decline in the vitality and in the quantity of the silk.

EMS induction increases carbohydrates in the crop plants and this increase was interpreted due to breakdown in the cellular respiration (MALLICK *et al.*, 1978). EMS in the present experiments also increases the neutral mucopolysaccharide profile indicating similar breakdown in the cellular respiration of the glands, followed and evidenced by a decline in the silk-spinning. Mucopolysaccharides are also partly digestive in function in the insects and such metabolic processes are rather hampered by the effect of EMS at the cellular level.

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CONTROL OF WHITE GRUB (*HOLOTRICHIA CONSANGUINEA* (BLANCH) IN GROUNDNUT CROP BY SEED DRESSING AND GRANULAR TREATMENT

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Seed dressing with chlorpyrifos in combination with bavistin or thiram is effective for control of white grub *Holotrichia consanguinea* and is recommended to the farmers being economical for its control on groundnut crop.

(Key words: control, white grub, *Holotrichia consanguinea*, groundnut, seed dressing, granular treatment)

INTRODUCTION

Seed dressing of groundnut with insecticides was undertaken for the first time by SRIVASTAVA *et al.* (1982) with chlorpyrifos at 25 ml/kg of seed, which gave protection against white grub and increased the yield of the crop. Previously, white grub control with various insecticides like aldrin, BHC, heptachlor, thiodan and phorate was carried out by a number of workers on various crops (SRIVASTAVA *et al.*, 1971; YADAV & YADAV, 1973; MANSOOR ALI, 1974; BHATNAGAR *et al.*, 1975; BAKHETIA & SUKHIJA, 1978; SRIVASTAVA & MATHUR, 1979; SRIVASTAVA *et al.*, 1981, 1983 a, b). Chlorpyrifos possesses a long residual property when sprayed on the cabbage and potato crops and applied to the soil (AGNIHOTRI *et al.*, 1981; GAJBHIYE *et al.*, 1981). BHATTACHRJEE & BHATIA (1981) reported that the grubs of *H consanguinea* showed the maximum infestation in the groundnut and soybean crops in the Amravati region of Maharastra and at Delhi, India; and also recommended the use of BHC 10% @ 25 kg/ha, which deserves critical examination before adopting on a large scale use.

The present investigations were undertaken by seed treatment of groundnut with carbofuran FP, chlorpyrifos, bavistin, thiram, chlorpyrifos + bavistin and chlorpyrifos + thiram, as well as with granular insecticides i.e., quinalphos, sevidol, carbofuran, phorate and diazinon by soil application.

MATERIAL AND METHODS

The trials for the control of white grub were conducted during 1983-1984 at the Govt. Farm Ujhani, Badaun district with 16 treatments including control, vide Tables 1 and 2. Fungicides were mixed with the insecticides to control "collar rot" disease of groundnut. The treated and untreated groundnut seeds were sown in field in a randomized block design by keeping individual plot area 24 sq. metre (6m × 4m) and each treatment was replicated three times.

The observations recorded were number of plants/plot, number of grubs/cubic metre and

yield plot which were analysed statistically for interpreting the comparative effectiveness of granular treatments and seed dresser.

RESULTS AND DISCUSSION

Maximum number of plants were present in diazinon (granule) treated plots (vide Table 1) closely followed by chlorpyrifos + thiram, chlorpyrifos + bavistin, chlorpyrifos (25 ml/kg) and carbofuran (vide Table 2). Among the treatments thiram was found poor with respect to the plant population, but

TABLE 1. Number of plants, grubs and yield plot. Treated as soil application.

No	Treatment	Average no. of plants at the time of harvest	Average no. of grubs/plot	Average yield in kg/plot
1.	Quinalphos 5G 30 kg/ha	70 (8.35)	5.6	1.450
2.	Sevidol (4:4)G 25 kg/ha	146.66 (12.03)	7.0	0.720
3.	Carbofuran 3G 50 kg/ha	141.00 (11.87)	6.3	1.000
4.	Phorate 10G 15 kg/ha	163.33 (12.78)	5.3	1.770
5.	Diazinon 5G 30 kg/ha	204 66 (14.30)	3.3	2.430
6.	Control (No treatment)	22.33 (4.82)	9.6	0.300
	C D at 5%	1.08	2.73	0.320

(Figures in parentheses are transformed values).

TABLE 2. Number of plants, grubs and yield/plot treated as seed dresser.

No.	Treatment	Average no. of plants at the time of harvest.	Average no. of grubs/plot	Average yield in kg/plot
1.	Carbofuran 50 FP 5 g/kg	121.00 (10.98)	8.0	0.760
2.	Carbofuran 50 FP 7.5 g/kg	171.00 (13.07)	7.3	0.940
3.	Carbofuran 50 FP 10 g/kg	146.00 (12.07)	7.0	1.250
4.	Chlorpyrifos 20 ml/kg+Bavistin 2 g/kg	188.33 (13.71)	3.6	4.170
5.	Bavistin 2 g/kg	82.66 (9.09)	10.0	0.580
6.	Thiram 2 g/kg	51.33 (7.13)	8.6	0.500
7.	Chlorpyrifos 12.5 ml/kg	90.00 (9.48)	5.7	1.020
8.	Chlorpyrifos 18.7 ml/kg	88.66 (9.41)	4.6	1.130
9.	Chlorpyrifos 25 ml/kg	179.33 (13.39)	4.3	2.750
10.	Chlorpyrifos 20 ml/kg+ Thiram 2 g/kg	193.66 (13.90)	3.6	3.150
11.	Control (No treatment)	23.33 (4.82)	9.6	0.300
	CD at 5%	1.08	2.73	0.320

(Figures in parentheses are transformed values).

found significantly superior to untreated plot.

With regards to the grub population minimum was found in case of diazinon (granules) treated plots as soil treatment closely followed by chlorpyrifos + bavistin, chlorpyrofos+thiram and chlorpyrifos (25 ml/kg) as seed dresser. The treatment with carbofuran, thiram and bavistin fail to reduce the population of grubs whose population was found at par with untreated plot.

The maximum and significant yields were recorded in chlorpyrifos + bavistin treated plots followed by chlorpyrifos + thiram, chlorpyrifos (25 ml/kg) and diazinon granules. Thiram and bavistin could not increase the yield over control at 5% level of significance.

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BRIEF COMMUNICATION

INFESTATION OF TEA MOSQUITO BUG *HELOPELTIS ANTONII* SIGNORET (HETEROPTERA : MIRIDAE) ON BLACK PEPPER AND ALLSPICE IN KERALA[1]

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Helopeltis antonii Signoret is recorded for the first time infesting black pepper *(Piper nigrum* L.) and allspice *(Pimenta dioica* (L.) in India.

(Key words: tea mosquito bug, *Helopeltis antonii*, black pepper, *Piper nigrum* L., allspice, *Pimenta dioica* L.)

Black paper *(Piper nigrum* L.) and allspice *(Pimenta dioica* L.) are spice crops cultivated mainly in parts of Kerala. About 20 species of insect pests have been recorded on black pepper in India (PILLAI, 1978); on all species very few insect pests have been recorded so far. We report here the incidence of tea mosquito bug *Helopeltis antonii* Signoret on black pepper and allspice in Kerala.

Black Pepper

Infestation by *H. antonii* on tender shoots and leaves was observed during February 1984 on young pepper vines at Kottaparamba (Calicut district, Kerala). On tender shoots, the damage was seen in the form of elongated necrotic lesions; on tender leaves irregular necrotic spots were distributed all over the leaf lamina (Fig. 1). When very young shoots were attacked it resulted in the complete drying up of the infested tissue. The affected vines were surrounded by cashew trees that were also infested by the bugs.

Allspice

Infestation by *H. antonii* was observed on eight year old plants at Peruvannamuzhi (Calicut district) on tender shoots and leaves during May 1983 to January 1984. On tender leaves the feeding activity of the bugs resulted in irregular necrotic spots that were confined mostly to the midrib region of the leaf lamina (Fig. 2). When the infested shoots were very tender they dried up completely. The intensity of damage to new shoots in the plants infested by the bugs ranged between 14.3-42.9 per cent.

H. antonii is a well-known pest of cashew in India and has a wide host range. The present report is the first record of the pest on black pepper and allspice in India. *H. antonii* has been reported to occasionally cause dieback of shoots and deformity of leaves of black pepper in Sarawak (BLACKLOCK, 1954).

[1] Contribution No. 422 of Central Plantation Crops Research Institute, Kasaragod.

Fig. 2. Tender shoot of allspice damage by *Helopeltis antonii*.

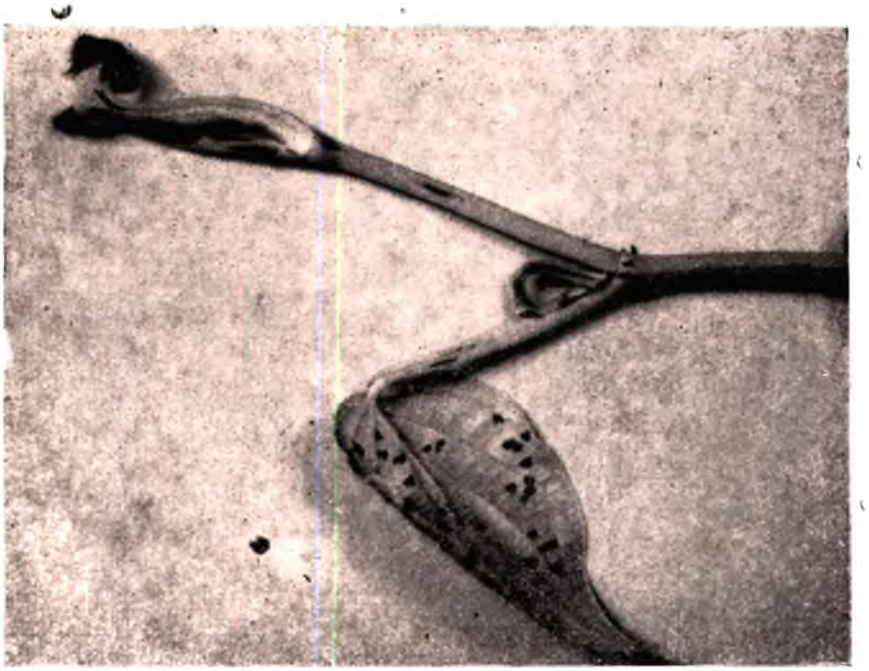

Fig. 1. Tender shoot of black pepper damaged by *Helopeltis antonii*.

Acknowledgements: We are thankful to Dr. M. K. NAIR, Joint Director, CPCRI Regional Station, Calicut for providing necessary facilities for carrying out the above study.

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BRIEF COMMUNICATION

ROLE OF WILD RICE AS AN ALTERNATE HOST TO RICE GALL MIDGE

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(Received 7 February 1985)

The degree of infestation of the rice gall midge *Orseolia oryzae* (Wood-Mason) and its seasonal variation are similar on cultivated rice and the wild rice *Oryza nivara*. The midge infestation and populatien of first and second instars of the midge are higher in the cold months than in the warm months and poupulation of third instar larvae higher in warm months

(Key words: rice gall midge, wild rice, alternate host)

Rice gall midge *Orseolia oryzae* (Wood-Mason) (Cecidomyiidae : Diptera) is a major pest of rice and several plants including wild rice have been reported as its alternate hosts (YEN *et al.*, 1941; REDDY, 1967; ISRAEL *et al.*, 1970). Role of the wild rice *Oryza nivara*, growing in the rice fields of Chhattisgarh studied under field conditions and presented in this paper.

Both wild rice and cultivated rice were collected at random from fields near Raipur at monthly intervals. The seasonal fluctuation was estimated, following the method of HUMMELEN & SOENARJO (1977). The stage of the larva in the plants was assessed by dissecting the growing point under microscope. At each occasion 50 tillers were dissected for each variety. These observations were made from June 1983 to May 1984.

The seasonal pattern of infestation of the midge in the field was similar in

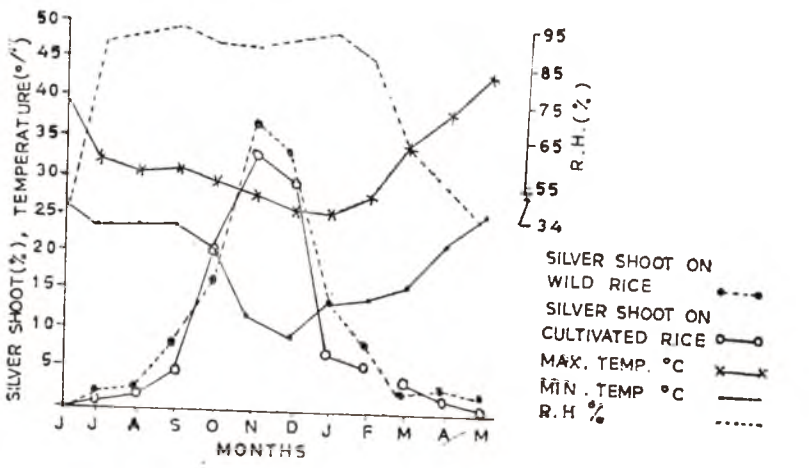

Fig. 1. Gall midge infestation under varying meteorological parameters.

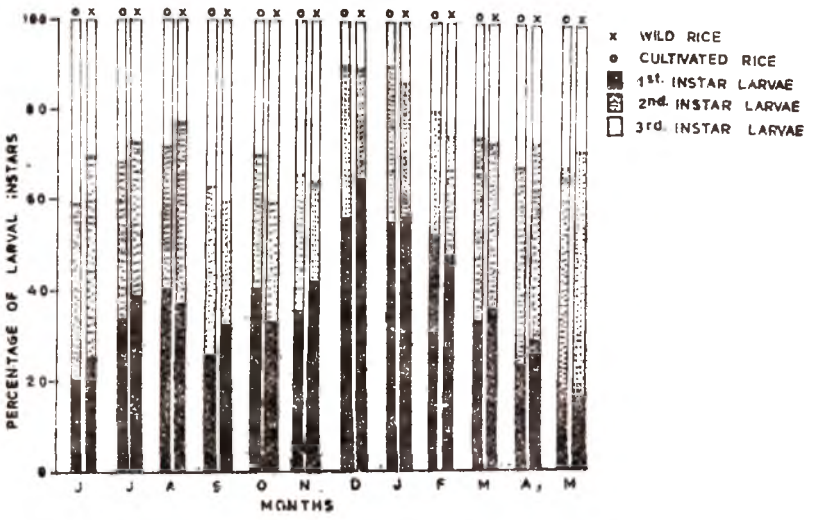

Fig. 2. Seasonal fluctuation of different larval instars of rice gall midge on rice.

both wild and cultivated varieties (Fig. 1). The degree of infestation on the two varieties was also nearly equal. The peak period of infestation coincided with the cold months. As regards the population of the different instars of the midge larvae (Fig. 2) it was observed that population of the first instar larvae was more in the cold months than in the warm months. The population of the second instar also showed a similar pattern. In the case of the third instar, however, the population was less in the cold than in the warm months.

These results thus indicate that the wild rice plays an important role as an alternate host helping to maintain the population of the pest in the eco-system during off season.

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BRIEF COMMUNICATION

ON THE SEX RATIO OF THE LAC ASSOCIATED INSECTS

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(Received 12 December 1984)

This note reports field sex ratios of nine hymenopterous parasitoids and two lepidopterous predators associated with lac insects.

(Key words: sex ratio, lac associated insects)

Due to their applied significance, the lac insect parasitoids, predators and parasitoids of lac predators have received considerable attention (NARAYANAN, 1962) but little is known about their sex ratio except for the scarcity of males in *Coccophagus tschirchi* Mahd. (MAHDIHASSAN, 1924) and preponderance of

TABLE 1. Field ratio of the common lac insect parasitoids, predators and parasitoids of lac predators.

Species	Lac insect strains			
	Rangeeni		*Kusmi*	
	n	% male	n	% male
A. Lac insect predators				
Eublemma amabilis	449	53.23	48	52.08
Holcocera pulverea	333	56.02	236	58.47
B. Lac insect parasitoids				
Chalcidoidea : Eulophidae				
Tetrastichus purpureus	3933	50.06	1453	44.59
Encyrtidae				
Tachardiaephagus tachardiae tachardiae	621	50.08	527	47.81
Parechthrodryinus clavicornis	396	40.40	72	34.72
Erencyrtus dewitzi	99	14.14	121	19.83
Tachardiaephagus tachardiae somervilei	0	0	125	28.80
Aphelinidae				
Coccophagus tschirchi	261	5.36	30	6.66
C. Parasitoids of lac insect predators				
Braconidae				
Bracon greeni	123	56.91	258	60.07
Apanteles tachardiae	77	44.51	40	57.5
Chalcidoidea : Elasmidae				
Elasmus claripennis	65	24.61	0	0

females in *Marietta javensis* (How.) (AGARWAL, 1969). Fortnightly field collections, made for the study of their abundance were scored for the sex ratio reported in this communication.

The results are expressed as percentage males throughout and are set out in Table 1. Although a large number of insects are reported to be associated with lac insects (VARSHNEYA, 1976), the results reported here only concern those which were of regular occurrence in lac and were recorded in sufficiently large number for this purpose. These results show a more or less balanced field ratio for the lac predators *Eublemma amabilis* Moore and *Holcocera pulverea* (Meyr.), their braconid parasitoids *Bracon greeni* Ashm. and *Apanteles tachardiae* Cam. and the two most numerous chalcid parasitoids of lac insects, *Tetrastichus purpureus* (Cam.) and *Tachardiaephagus tachardiae tachardiae* (How.) but that of the other chalcid parasitoids of lac insects namely *Parechthrodryinus clauicornis* (Cam.), *Tachardiaephagus tachardiae somervilei* (Mahd.), *Erencyrtus dewitzi* (Mahd.) and *C. tschirchi* and the only chalcid parasitoid of lac predator *E. amabilis* namely *Elasmus claripennis* (Cam.) deviated significantly from parity in favour of the famales. This deviation was maximum for *C. tschirchi* which recorded only about 5.36 per cent males. It will now be of interest to study the causes for these deviations.

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STUDIES ON THE OVIPOSITION SITE OF *DIAERETIELLA RAPAE*, A PARASITOID OF *LIPAPHIS ERYSIMI* (KALT.)

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Diaeretiella rapae, a parasitoid of *Lipaphis erysimi* in north western districts of Uttar Pradesh, prefers oviposition in abdomen of the host. The eggs deposited in head, legs, thorax, cornicles and cauda, failed to develop further. In abdomen too, points of oviposition have been observed more in mid dorsal and mid lateral parts. This is due to the large and convex shape of the abdomen which covers near about $\frac{3}{4}$th part of the host body.

(Key words: Diaeretiella rapae, Lipaphis erysimi, parasitoid, oviposition point, abdomen)

INTRODUCTION

Diaeretiella rapae (M' Intosh) (Hymenoptera—Braconidae—Aphidiinae) has been reported as an internal parasitoid of many aphid species in various foreign countries (ASKARI *et al.*, 1979; FULLAWAY, 1914; HAFEZ, 1960, 1961; MASON, 1922; SEDLAG, 1959; SHANDS *et al.*, 1955; SMITH 1919; STICKLAND, 1917; TAKADA, 1976; PIMENTEL, 1961). In India, however, this parasitoid was first observed in Kulu Valley attacking *Brevicoryne brassicae* L. (BATRA & WADHI, 1962). For the first time KUNDU *et al.* (1965) recorded this parasitoid parasitizing the mustard aphid, *Lipaphis erysimi* from Hardwar, Dehradun and Kalimpong. Later on *Diaeretiella rapae* has also been reported from this aphid species by ATWAL *et al.* (1969) and DHIMAN & KUMAR (1983). Although, a good deal of work has been done on this parasitoid, no studies have so far been made on its oviposition site and present investigation is an endeavour in this regard.

MATERIALS AND METHODS

Mustard aphid, *Lipaphis erysimi* were cultured on potted plant of radish placed in a wire gauze cage ($1 \times 0.5 \times 0.5$ m) under field condition during April, 1984. Mummies of the aphid collected from the field, were brought to the laboratory and reared in glass chimney for the emergence of parasitoid, *D. rapae*.

Fifty nymphs from first to fourth instar of the aphid were taken out from the culture along with the host leaf part and kept in a petridish (10 cm in diameter). Now, a newly emerged, fully fed (on 30% honey solution), mated female was taken out from the glass chimney and introduced into the petridish and mouth of the dish was covered by a thin glass plate. Observations were made under the stereoscopic binocular microscope.

To ascertain the position of the oviposited egg in the host body, few parasitized nymphs were taken out and dissected under binocular in 70% alcoholic media by sticking the host on a transparent cellophane strip. Each and every part, viz., antennae, head, thorax, abdomen, legs, cornicles, cauda, of the parasitized host body was dissected carefully. Some of the parasitized nymphs were kept alive to note the mummification on a daily fresh

supply of radish leaf in glass chimney covered at top by fine muslin cloth. The radish leaves were preferred for rearing the host because (i) radish plants are cultivated throughout the year in this locality (ii) aphid infestation occurs more on this plant and (iii) *Diaeretiella rapae* too, parasitizes the aphid in large on this plant in contrast to mustard.

RESULTS AND DISCUSSION

Observations on the location of oviposition sites in 675 specimens of *Lipaphis erysimi* were made and the data are tabulated in Tables 1 and 2 which reveal that the points of oviposition in aphid body are mainly confined to abdomen although cases of egg deposition in other parts of the body, viz., head, antennae, thorax legs, cornicle and cauda have also been noticed. In such cases the development of *Diaeretiella rapae* could proceed only upto first larval stage, after which the larva died. Only the ova deposited in abdomen completed the full development and produced the adult parasite.

TABLE 1. The number of points of oviposition in different parts of the aphid body.

No.	Part of the body	no. of oviposition points	degree of parasitism*
1.	Head	2	—
2.	Antennae	5	—
3.	Thorax	25	±
4.	Legs	92	—
5.	Abdomen	567	++
6.	Cornicles	6	—
7.	Cauda	9	±

* + indicates parasitism of 30% (or multiple) of the aphids.
± indicates parasitism of 8–12% of the aphids
– indicates parasitism less than 8% of the aphids.

It seems that the more percentage of the oviposition in abdominal region is a matter of chance because the abdomen is the only enlarged, swollen part of the host body which comes first in contact with the ovipositor and remaining parts get least chance. Abdomen constitutes the major part of the aphid body (about $\frac{3}{4}$th) which also consists of consumable food, viz., nervous tissue, digestive system, reproductive system and adipose tisssue, for the developing parasitic larva.

Moreover, in abdomen too, the points of oviposition were noticed by taking three district divisions, anterior, middle and posterior of each dorsal and lateral side. Dorsal side of abdomen is preferred more for oviposition in contrast to lateral side (Table 2). On dorsal and lateral sides, it is the mid dorsal and mid lateral part of the abdomen which gets more prickings for oviposition. The reason is simple, the mid abdominal part of the aphid is dorso-laterally convex and fully stretched.

TABLE 2. The number of oviposition points in different parts of the abdomen of the aphid.

No.	Part of the abdomen	number of oviposition points		degree of parasitism in per cent
1.	Antero-dorsal	78		20
2.	Mid-dorsal	264	409	40
3.	Postero-dorsal	67		20
4.	Antero-lateral	20		5
5.	Mid-lateral	47	92	10
6.	Postero-lateral	25		5

The abdomen of the aphid is divided into 26 blocks A to Z (Fig. 1). The mid-dorsal area, containing, G, H, I, L, M, N, Q, R and S blocks, is pricked

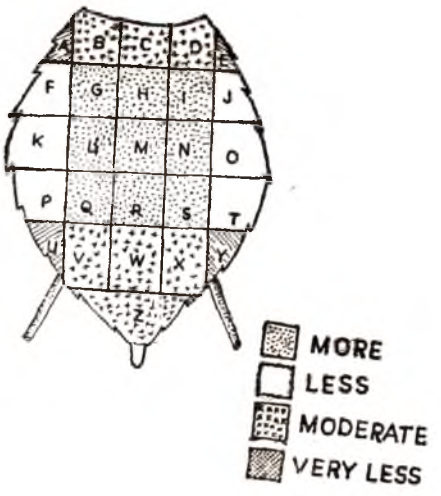

Fig. 1. Dorsolateral view of aphid abdomen divided into 26 blocks A-Z indicating the intensity of prickings is different areas.

more, resulting in the deposition of more number of eggs which undergo full development till emergence. Area consisting A, E, U and Y blocks has least number of prickings and eggs. Only few eggs deposited on this area reach full development.

In fifteen cases, in the attempts of ovipositing in posterior part of the host abdomen, the female *Diaeretiella rapae* came in contact with the honey dew excretion. Due to this, the ovipositor became either temporarily or permanently incapicitated by blockage. Under such condition oviposition was postponed by the female parasite.

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FURTHER OBSERVATIONS ON THE NATURAL ENEMIES OF *LYMANTRIA OBFUSCATA* WALKER (LYMANTRIIDAE : LEPIDOPTERA) IN KASHMIR

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Egg mass density of *Lymantria obfuscata* Walker (Lymantriidae : Lepidoptera) and their parasitism was observed. *Anastatus kashmirensis* Mathur the only egg parasite, was observed to parasitise between 3.49 and 9.92 per cent of eggs. Two larval parasites namely *Exorista rossica* and *Compsilure* sp. were recorded parasitising upto 28.66 per cent. Apart from *Brachymeria intermedia* Nees, *Pimpla* sp. *Theronia* sp. *Tetrastichus* sp. and *Eurytoma* sp., a new parasite *Brachymeria lasus* Walker was recorded from pupae. The average parasitism of pupae ranged between 2.62 and 20 00 per cent during 1980 to 1983. Average egg mass density estimated in 0.01 ha circular plot was between 501.3 to 3636.3.

(*Keywords:* natural enemies, *Lymantria obfuscata*, Kashmir)

INTRODUCTION

Although many supressive measures (DAR *et al.*, 1977) bave been recommended, *Lymantria obfuscata* remains a problem in Kashmir. Repeated *Lymantria obfuscata* defoliation continuously for seven years was found to cause 8.4 to 36.1 per cent tree mortality (SHIEKH 1975). It was first recorded as a serious pest of apple, apricot, willow and poplar (FLETCHER, 1919). Later it has been reported on cashew from Tamil Nadu (MISRA & BASUCHOUDHURI, 1976). ZUTSHI (1967) reported the natural enemies of this pest from Kashmir. The present studies have been aimed to have the preliminary account of the parasitiods of *Lymantria obfuscata* and the population density in various geographical areas of Kashmir.

MATERIALS AND METHODS

The study was conducted in six districts in Kashmir Valley. Stands were composed of at least 60 per cent apple while poplar, willow and walnut constituted most of the remainder. 1980 only four study plots were established in district Budgam. The number increased to 18, 20 and 27 during 1981, 1982 and 1983 respectively. Plots of 0.01 ha area were established within each site, and five sample trees in each plot were labelled for observations.

Collections were initiated in October and and egg masses were sampled for parasitism and population density counts. The egg mass density was determined by counting the number of egg masses visible at three levels; ground, bole and crown, assuming that the host immatures collected within each stratum were representative of the populations at those strata. Parasitism of eggs was determined by the presence/absence of holes in the sample of 50 eggs drawn from the egg masses. The collection was continued in the first week of

April when the larvae were in first stadium until 75 per cent of the pupae had developed into adults. The larvae were collected from each site once a week. Also one collection of pupae was made m each site. The parasites recovered were identified by Commonwealth Institute of Entomology, London.

Early stage larvae were collected randomly from crown foliage, tree boles and ground litter. Late stage larvae and pupae were collected by stappling 30 cm wide burlap skirts at waist to breast height around the trunk of trees. Once a week 50 larvae under each band were collected. Feral pupae were segregated by sex. Field collected larvae were transferred to rearing cages with maximum of 50 larvae per cage. They were fed willow foliage and reared at room temperature. The average maximum and minimum temperature during the course of investigations was 24.36°C and 12.36°C respectively. The feral pupae were kept at room temperature in cages with 50—70 in each container.

RESULTS AND DISCUSSION

The population trend as indicated by egg mass density (Table 1) showed higher level of the pest in two districts of Pulwama and Budgam particularly during first two years of study. Kupwara

TABLE 1. Egg mas density and per cent parasitism of *Lymantria obfuscata* Walker.

Location	year	Mean egg mass density 0.01 ha plot	per cent parasitism		
			egg	larvae	pupae
Srinagar	1980	1861.1	4.21	—	—
	81	1658.0	3.55	13.63	5.96
	82	1586.5	3.66	10.99	4.81
	83	1025.4	8.33	5.38	5.650
Budgam	1980	3781.2	4.05	18.71	19.46
	81	5093.7	4.37	21.65	20.00
	82	1540.4	3.87	5.66	6.20
	83	1001.5	8.50	4.87	9.40
Anantnag	1980	1000.0	3.54	—	—
	81	1793.5	3.98	13.63	10.80
	82	1676.4	3.94	18.00	2.70
	83	1376.3	8.27	2.25	8.30
Pulwama	1980	3636.3	4.35	—	—
	81	3727.4	5 05	17.21	11.85
	82	1941.3	4.77	11.53	5.92
	83	1523.6	9.92	7.04	10.00
Baramulla	1980	1316.6	4 76	—	—
	81	1589.0	3.82	28.66	8.72
	82	1408.3	3.68	20.65	3.76
	83	1201.2	7.80	4.16	8.13
Kupwara	1980	925.0	3.45	—	—
	81	1050 5	3.49	—	—
	82	677.6	3.52	11.11	2.62
	83	501.3	6.60	2.13	1.33

area was found to support lower population of this pest. There was, however, a fall in the population in 1982 in almost all the six districts of Kashmir. The results in respect of egg mass population within the study plots provide relevent information on the fluctuations in the population of *Lymantria obfuscata*. Further mortality potential on account of its length of exposure to various mortality factors, seems to be much greater in the egg stage of *Lymantria obfuscata*. No correlation between the egg mass count and apparant parasitism of subsequent stages was attempted.

In a period of four years from 1980 to 1983 as many as 2702 egg mass samples were collected from different sites of Kashmir Valley and observed for parasitism. There was no significant variation among various localities in the parasitism of eggs in 1980 to 1982 which ranged on an average between 3.45 to 5.05 per cent but in 1983 the parasitism recorded was higher than the previous three years and ranged between 6.60 to 9.92 per cent. Some areas of district Pulwama were noted to have apparantly higher parasitism (9.92 per cent) of eggs. It could be seen that there is detectable relationship between the egg mass density and the apparent parasitism. The emerging parasites from the field collected egg masses stored in the laboratory were identified as *Anastatus kashmerensis* Mathur. Other egg parasites like *Anastatus* sp. and *A. bifasciatus* observed by RAO (1966) were not recovered.

Parasitism of larvae in Budgum area was as high as 18.71 per cent during 1980 while in 1981 it ranged between 13.63 and 28.66 per cent. However, low parasitism of 5.60 to 18.00 and 4.08 to 6.05 per cent was recorded in 1982 and 1983 respectively. The larval parasites recovered were identified as *Exorista rossica* and *Compsilura* sp. (Tachinidae: Diptera). *Drino discreta* (Tachinidae : Diptera) and *Apanteles* sp. (Brachonidae: Hymenoptera) as observed by RAO (1966) were not recorded from any study area.

The prominent pupal parasite viz: *Brachymeria intermedia* Nees (Chalcididae: Hymenoptera), *B. lasus* Walker (Chalcididae : Hymenoptera) *Theronia* sp. (Ichneumonidae : Hymenoptera), *Pimpla* sp. (Ichneumonidae : Hymenoptera), *Tetrastichus* sp. (Eulophidae : Hymenoptera) and *Eurytoma* sp. (Eurytomidae : Hymenoptera) were observed in Kashmir during the present studies. The extent of parasitism recorded was same as that of larvae. During 1980 and 1981 the parasitism recorded was as high as 20.00 per cent whereas during 1982 and 1983 it was as low as 2.62 to 6.20 per cent and 1.33 to 10.00 per cent respectively. *Brachymeria lasus* is a new record on *Lymantria obfuscata* from Kashmir.

Acknowledgements. The authors wish to thank Prof. AHMAD Vice Chancellor and Mr. M. A. DAR Director Researches, Sher-e-Kashmir University of Agricultural Sciences and Technology, Sri-Srinagar for providing the facilities.

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BIOECOLOGY OF A DIMORPHIC ASSASSIN BUG, *EDOCLA SLATERI* DISTANT. (HETEROPTERA : REDUVIIDAE)

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Edocla slateri Distant. a dimorphic assassin bug lays dark brown eggs in batches 33 ± 4.3 days after imaginal moult. Eggs are glued to one another and to the substratum with cementing material. Fuscus and testaceous nymphs hatch from the eggs in between 15—21 days. Stadial period from first instar to adult ranges from 44 to 92 days. Adult females live longer than males. Sex ratio of males and females of laboratory raised bugs for two generations, is 1:1 and 3:4 respectively.

(*Keywords*: dimorphic assassin bug, oviposition, incubation, stadial periods, nymphs, longevity, sex ratio, *Edocla slateri*)

INTRODUCTION

DISTANT (1903) in Fauna of British India, described only an alate *Edocla slateri*. The present investigation reveals that *Edocla slateri* Dist. is a dimorphic assassin bug; males are alate and females are micropterous. It is an entomosuccivorous, polyphagous, crepuscular, piceous assassin bug found in the scrub jungles, semiarid zones and tropical rain forests. It is a potential predator on termites and camponotine ants. Bioecology of a few species of Oriental Reduviids is reported. (BOSE, 1949; JOSEPH, 1959; AMBROSE & LIVINGSTONE, 1979: LIVINGSTONE & AMBROSE, 1978; AMBROSE, 1980, 1983).

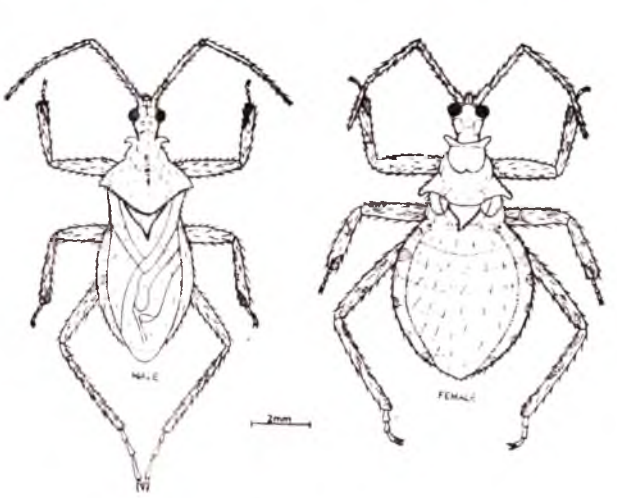
MATERIALS AND METHODS

Gravid adult female *E slateri* were collected from the Thirueengoimalai scrub jungle in Trichy District and Okkanintarpothai scrub jungle in Tirunelveli District, Tamil Nadu. They were reared in plastic containers (12 × 6 × 4 cm) on grasshoppers, house flies and camponotine ants. The different batches of eggs laid by the females were allowed to hatch separately in plastic containers with wet cotton swabs for maintaining optimum humidity (85%) separately. The cotton swabs were changed periodically in order to prevent fungal attack. The nymphs hatched were separated in plastic containers and reared on house flies and camponotine ants. Observations on oviposition, incubation and stadial periods, nymphal mortality, adult longevity and sex ratio were recorded. Two generations were thus raised in the laboratory.

OBSERVATIONS AND DISCUSSION

Microhabitat: *E. slateri* is found in concealed microhabitats such as underneath the stones and crevices, mostly near the small bushes. The nymphal instars are found in solitary confinement and are quite difficult to discern due to their camouflaging. Adults are also found to occur solitarily and never in congregation or in pairs or in association with any other insects.

Egg and oviposition: *E. slateri* lays its first batch of eggs 33 ± 4.3 days after imaginal moult. Eggs are laid in batches each attached to the other and basally



glued to the substratum with ash coloured cementing material. The eggs are dark brown, elongately oval with pale yellow opereculum. Chorion bears irregular sculpturations and appears deeply regulosed. Operculum is transparent and membranous without any prominent sculpturations. In the laboratory, eggs are attached to the lids, sides and bottom of the containers both vertically and horizontally, and are also found inserted into the cotton swabs. The total length of the egg is 1.28 ± 0.03 mm, its width 0.64 ± 0.05 mm. The opercular height is 0.45 ± 0.02 mm and its width 0.11 ± 0.02 mm. *E. slateri* prefers to glue its eggs to the fresh excreta. Seasonal influence on oviposition as observed in *Rhinocoris albospilus* (ODHIAMBO, 1959) and *Zelus* sp. (RALSTON, 1977) is not found in this bug.

Table 1 summarises the oviposition pattern and hatchability. During its life span (66.5 ± 18.13 days) it records 50.37 ± 6.49 of egg laying days (oviposition index). An average of 25.66 ± 10 99 batches of eggs with a total of 128.83 ± 48.81 eggs are laid by a female. Out of these eggs 87.33 ± 31.98 nymphs hatched recording 68.42 ± 2.82% of hatching. Guarding the eggs and showing parental care, either by males or females, towards nymphal instars as reported in *Rhinocoris albospilus* (ODHIAMBO, 1959) and *Zelus* sp. (RALSTON, 1977) are not found in *E. slateri*.

Incubation and hatching: Under laboratory conditions (temperature 32°C, relative humidity 80-85%, photoperiod 11–13 hrs), the eggs hatch in between 15–21 days (18.5 ± 3.5 days). Hatching invariably takes places in the afternoon and on rare occasions they are found to hatch in the forenoon. During eclosion the head comes first followed by the thorax. Soon after the head and thorax came out it starts a wriggling movement in the body with backwardly folded legs. This movement helps the remaining portion to come out. Eclosion and hatching extend for 5–6 minutes. Pale ochraceous nymphs turn into brown within an hour. The first task of the nymphs during the initial mean period of fifteen minutes after eclosion is to gather the empty shells as well as the

TABLE 1. Mean (6 ± SD) Values of oviposition pattern and hatchability in *E. slateri*.

1.	Adult female longevity in days	66.5 ± 18.13
2.	Age at which first batch of eggs laid in days	33 ± 4.3
3.	Index of oviposition days	50.37 ± 6.49
4.	Total number of batches of eggs laid	25.66 ± 10.99
5.	Minimum number of eggs per batch	1 ± 0
6.	Maximum number of eggs per batch	10.33 ± 1.59
7.	Average number of eggs per batch	5.12 ± 0.87
8.	Total number of eggs laid	128.83 ± 48.81
9.	Total number of nymphs hatched	87.33 ± 31.98
10.	Hatching percentage	68.42 ± 2.82
11.	Frequency of 0% hatching	2.33 ± 1.10
12.	Frequency of 100% hatching	5.33 ± 1.37

opercula as a spontaneous act of camouflaging. But the nymphs do not exhibit the practice of probing the egg shells soon after eclosion as reported in *Rhodnius prolixus* (BREECHER & WIGGLESWORTH, 1944).

Stadial period: All the forty five nymphs observed in the laboratory for two generations moult and emerge in the early hours of forenoon. The stadial period between the first and second instar is 10.9 ± 3.34 days and that of second and third instar is 12.5 ± 5.3 days; the third stadial period is 11.04 ± 5.34 days the duration of the fourth instar is 12.59 ± 3.66 days. From the fifth instars the males emerge in 16.4 ± 4.58 days and the females emerge in 15 ± 3 days. Stadial period from first instar to adult ranges from 44 to 92 days (62.57 ± 13.97).

KEY FOR THE IDENTIFICATION OF NYMPHAL INSTARS

1. Scape and pedicel equal in length and shortest, length of abdomen equals its width .....First instar.
— Scape and pedicel unequal in length, scape the shortest, abdominal length exceeds its width.....(2)
2. Anteocular area longer than postocular area, head and thorax smooth without any prominent sculpturations, wing buds not developmed.....Second instar.
— Anteoclur area shorter than postocular area, head and thorax with prominent sculpturations, wing buds developed.....(3)
3. Wing buds extends up to first abdominal segment .....Third instar.
— Wing buds extends beyond the first abdominal segment.....(4)
4. Wing buds exterds up to second abdominal segment, no prominent median abdominal stiff hairs.....Fourth instar.
— Wing bud extends upto fifth abdominal segment, median abdominal stiff hairs prominent.....Fifth instar.

Nymphal mortality: Nymphal mortality is mainly due to their pronounced cannibalistic tendency. Abnormalities in hatching and moulting, combat against powerful preys are other causes of nymphal mortality. Highest nymphal mortality is recorded in first instar (40.27%),

followed by second instar (9.72%). Third, fourth and fifth instars recorded a nymphal mortality of 1.38% each.

Adult longevity and sex ratio: The life span of adult female is 66.5 ± 18.13 days and that of adult male is 47.5 ± 30.64 days.

The sex ratio of males and females is recorded as 1:1 in the first generation and 3:4 in the second generation.

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REPORTS AND NEW RECORDS

ON THE OCCURRENCE OF *THALASSODES* SP. (GEOMETRIDAE : LEPIDOPTERA) ON CARDAMOM SEEDLINGS *ELETTARIA CARDAMOMUM* MATON)

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(Received 22 February 1985)

Caterpillars of *Thalassodes* sp. were found feeding on cardamom seedlings in Tamil Nadu.

(Key words: Thalassodes sp., caterpillars, *Elettaria cardamomum)*

Caterpillars of *Thalassodes* sp. (Fig. 1) were found feeding on the tender leaves of cardamom seedlings in the Regional Research Station of the Indian Cardamom Research Institute, Thadiyankudisai, Tamil Nadu. The caterpillar was brown with a smooth body, measuring 5—7 cm long when fully grown. Pupation took place inside a light cocoon on the leaf. The adult was a medium sized, pale green moth.

The other species of geometrid caterpillars infesting on cardamom are those of *Anisodes denticulatus* Hamps and *Eumelia rosalia* Cram, both minor pests (Nair, 1975).

Thanks are expressed to the Director and Dr. J. D. HOLLOWAY of the Commonwealth Institute of Entomology, London for indentifying the insect and to Mr. P. K. ZACHARIAH for the facilities provided.

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NAIR, M. R. G. K. (1975) *Insects and Mites of Crops in India,* ICAR, New Delhi.

Fig. 1. *Thalassodes* caterpillar feeding on leaf of cardamom seedlings.

NEW RECORD OF A BRACONID PARASITE ON CARDAMOM HAIRY CATEPILLAR, *EUPTEROTE CARDAMOMI* RENG. AND CARDAMOM LOOPER, *EUMELIA ROSLIA* CRAM

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(Received 4 March 1985)

A braconid parasite *Apanteles* sp. was found to parasitize the cardamom hairy caterpillar *Eupterote cardamomi* and the cardamom looper *Eumelia roslia* in Tamil Nadu.

(Key words: braconid parrsite, *Apanteles,* cardamom hairy caterpillar, cardamom looper, *Eupterote cardamomi, Eumelia)*

Hairy caterpillars are major pests of cardamom *(Elettaria cardamomum* Maton) occurring sporadically at intervals of several years (NAIR, 1975). The latest serious outbreak occurred in Mackimalai area of Kerala in 1981—1982.

During a surveillance study undertaken at the Regional Research Station of the Indian Cardamom Researoh Institute, Thadiyankudisai, Tamil Nadu in May 1984 large number of parasitized caterpillars of *Eupterote cardamomi* Reng. were seen on cardamom plants. The parasitized caterpillars in due course stopped feeding and became motionless. Subsequently, white silken cocoons appeared along the lateral and posterior sides of the caterpillar (Fig. 1). A mean number of 78 adult parasites emerged per caterpillar. The parasite was identified as *Apanteles* (s. l.) sp. *(vitripennis* species group=*Glyptapanteles)* (Braconidae : Hymenoptera).

The geometrid cardamom looper,

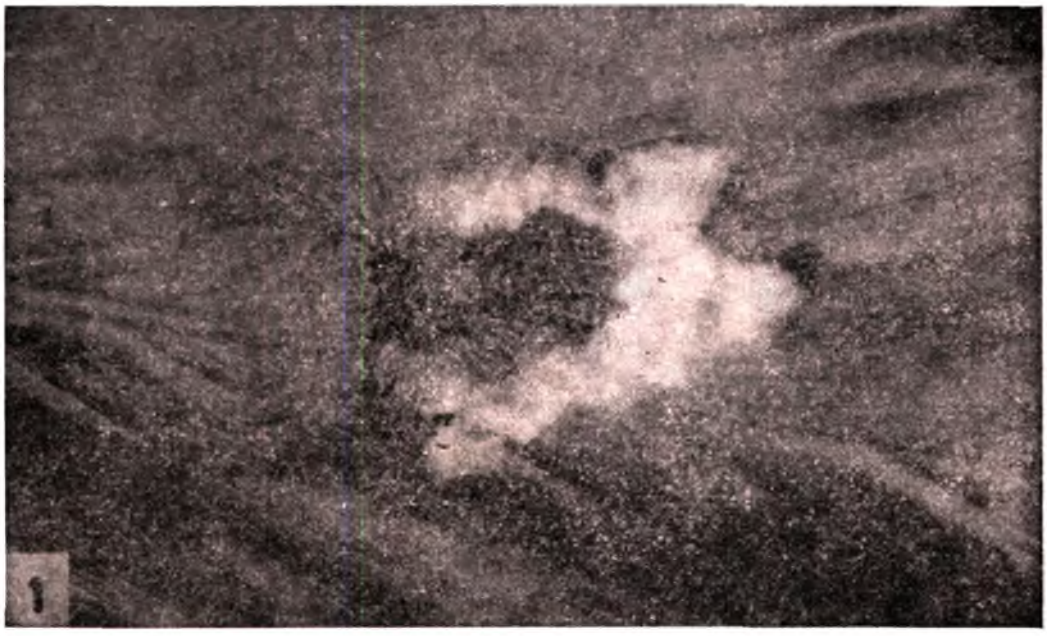

Fig. 1. Parasitised caterpillar of *Eupterote cardamomi* showing the parasite cocoon.

Eumelia rosalia Cram. was also found to be parasitized by the same species.

Sturmia sericariae (Tachnidae) and *Aphanistes eupterotes* (Ichnemonidae were earlier recorded parasitizing *E. cardamomi* (NAIR, 1975).

Acknowledgements: I owe my sincere thanks to the Director and Dr. A. D. AUSTIN, Commonwealth Institute of Entomology, London who helped in identifying the parasite. Thanks are due to Mr. P. K. ZACHARIA, Deputy Director (Research), Indlan Cardamom Research Institute, Myladumpara for encouragment.

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HELIOTHIS ARMIGERA (HUBNER) ON RIDGE GOURD IN RAJASTHAN A NEW PEST HOST RECORD

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(Received 14 May 1985)

The larva of *Heliothis armigera* was found to feed on the ridge gourd fruits at Jobner Rajasthan for the first time

(Key words: Heliothis armigera, ridge gourd, new record)

The gram pod borer, *Heliothis armigera* (Hübner) is a serious pest of gram and tomato. It also feeds on a large number of field-, garden- and ornamental plants including vegetables *viz.*, okra, brinjal, cabbage, carrot, lettuce and onion (SINGH, 1984). BHATNAGAR & DAVIES (1978) recorded 50 species of crop plants and 48 species of weed and wild species of plants as host for this pest in Andhra Pradesh.

The larva of *H. armigera* was observed to feed on ridge gourd fruits in *kharif*, 1981 at Jobner in Rajasthan for the first time. The caterpillars when young feed first on the rind, and are not discernible from a distance easily. The incidence was recorded from first week of October to second week of November. The average population of the caterpillars on total 30 plants observed was quite low, being only 8.

Host cross overs and multiple races of *Heliothis* spp. have alarmed the cultivators and scientists alike. This is perhaps associated with changes in cropping pattern and practices. In the present case, the pest might have crossed over to ridge gourd from tomato plants because of few fruits and only the fruits of ridge gourd were found in the locality at that time. After completing one generation on ridge gourd, the insect might have shifted back to other preferred hosts.

At present, this insect is a minor pest of cucurbit but it may assume pest status in Rajasthan as the state provides maximum potential for the cultivation of cucurbits due to favourable agro-climatic conditions.

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NEW HOST PLANTS OF *HAPLOTHRIPS LONGISETOSUS* ANANTHAKRISHNAN

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(Received 24 October 1984)

Haplothrips longisetosus was found to infest on *Amaranthus spinosus, A. viridis, A. oleosa* and *Chenopodium althelminticum.*

(Key words: Haplothrips longisetosus, Amaranthus spinosus, A. viridis, A. oleosa, Chenopodium althelminticum)

ANANTHAKRISHNAN (1955) reported *Haplothrips longisetosus* from Malabar (Kerala) infesting a wild flower. He did not mention the name of the plant. Since then no other host plant of this thrips has been reported. During the course of a survey in July, 1984, for the collection of insect fauna of district Saharanpur (U. P.), four more new host plants are observed. These are *Amaranthus spinosus*, *Amaranthus viridis*, *Amaranthus oleosa* (family–Amarantaceae) and *Chenopodium althelminticum* (family–Chenopodiaceae). The thrips infests the inflorescence of these aforesaid plants and occur throughout the summer and rainy season from March to mid November. During winter months, December to February, the aforesaid host plants perished and it seems that then *H. longisetosus* migrates on to other unknown host plants. Maximum number of the thrips are found in June to September at 28 to 37°C and 20 to 85% RH. Among the host plants preference in nature is given to *A. spinosus* (at an average of 32 thrips per plant). Minimum number (5 per plant) is found on *C. althelminticum*. Availability of this thrips on more than one host plant establishes its polyphagous nature.

The author is thankful to Prof. S. K. UPADHAYA, Taxonomist, Botany Department, M. S. College, Saharanpur, for the identification of the host plants.

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NEW RECORDS OF PARASITES OF FLUSHWORM AND LEAF ROLLER OF TEA

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The caterpillars of the tea leaf roller *Caloptilia theivora* is attacked by the parasites *Sympiesis dolichogaster* and *Mestocharella javensis*, and of the flushworm *Cydia leucostoma*, by *Apanteles aristaneus*, *Fornicia* sp., *Plectochorus* sp. and *Eriborus* sp.

(Key words: tea leaf roller, flush worm, parasites)

The leaf roller, *Caloptilia theivora* (Wals.) (Lepidoptera : Gracillaridae) and the flushworm, *Cydia leucostoma* (Meyr.) (Lepidoptera : Olethreutidae) are widely distributed in all the tea growing areas of India and cause damage to tender leaves and shoots of tea *(Camellia sinensis)*. They are commonly observed in fields recovering from pruning, but chemical control measures are seldom adopted against these pests since their populations are, to a very large extent, controlled by many natural enemies. Recently, SHARMA (1979) listed various parasites, predators and pathogens of tea

pests in India and noted that the leaf rollers are attacked by the eulophids, *Asympiesiella India* (Girault), *Elachertus* sp. and another species belonging to *Miotropis*. Extensive surveys on the natural enemy complex of flushworm had revealed the presence of a dozen species of parasites belonging to Eulophidae, Ichneumonidae, Braconidae and Bethylidae (Rao *et al.*, 1970).

While studying the parasites of the caterpillar pests of tea, the authors noticed two species of eulophids parasitising the larvae of *C. theivora*. They were identified as *Sympiesis dolichogaster* Ashmead and *Mestocharella javensis* Gahan. These species are recorded as parasites of *C. theivora* for the first time.

The collection and rearing of flushworms from the tea fields of Anamallais had shown that many larvae were parasitised by the ichneumonids *Plectochorus* sp. nr. *iwatensis* Uchida, *Eriborus* sp. and the braconids *Apanteles aristaneus* Nixon, *Apanteles* sp. *(glomeratus* group) and *Fornicia* sp. Many species of *Apanteles* belonging to *ultor*, *glomeratus* and *vitripennis* groups have been known to be active in the tea fields. But the present report forms the first record of *A. aristaneus* and *Fornicia* sp. parasitising the larva of *C. leucostoma*. Similarly, parasitization of flushworm by *Plectochorus* sp. and *Eriborus* sp. has not been reported earlier though other species of ichneumonids belonging to *Aptesis*, *Meloboris* and *Pristomerus* have been reared from this pest.

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BRIEF COMMUNICATION

BIOLOGY OF *LYMANTRIA MARGINATA* WLK. (LYMANTRIIDAE : LEPIDOPTERA), A MANGO DEFOLIATOR IN WESTERN UTTAR PRADESH

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Lymantria marginata Wlk., a defoliator of mango of recent origin, is a sporadic pest in Western Uttar Pradesh. The biology was completed in 53.14 ± 0.43 days with six instars in male and seven in female.

(*Keywords: Lymantria marginata*, mango defoliator, life cycle)

In the recent past, the caterpillars of *Lymantria marginata* Walk. were in an alarming proportion on mango crop *(Mangifera indica)* in Western Uttar Pradesh. India is the world's largest producer of mango (RAO, 1984), and Uttar Pradesh alone accounts for 4,20,000 ha of land under mango. BUTANI (1979) described a few immature lymantriids defoliating mango namely, *Euproctis flava* Berm., *E fraterna* Moore, *E. lunata* Wlk., *E. xanthosticha* Hampson and *Lymantria beatrix* Stoll. The biology of *L. marginata* Wlk., yet an unreported defoliator of mango in India, has been undertaken.

Laboratory reared adults of *L. marginata* were allowed to lay eggs. Each neonate caterpillar was placed in separate petri dish and allowed to feed on the mango leaves. A record of incubation period, percentage hatching, longevity in both the sexes and mortality was maintained. The maximum and minimum temperatures in the present study were 31.85 ± 0.02°C and 27.94 ± 0.02°C respectively. The relative humidity was 65.82 ± 0.29%.

Biology: Different stages of *L. marginata* were found on mango tree throughout the year. It has a life span of about 53.14 ± 0.43 days (Table 1).

Egg: The eggs of *L. marginata* were laid without any cover of hair in clusters on the surface of the bark, crevices and hollows of the trees. Under laboratory condition a single female laid 120 to 377 eggs in six days. The eggs were ovoid with flattened base. The greyish fresh eggs turn dark after 2 or 3 days of oviposition. The chorion of the egg was of hexagonal texture with a micropyle middorsally. Each egg measured about 0.9782 ± 0.0083 mm in length and 0.8346 ± 0.0012 mm in width, with a hatching period of 9 to 10 days, and 92.95% hatching.

Larva: The newly emerged caterpillars congregated near the egg mass and started feeding on empty egg shells. They were light brown in colour and turned greyish black in successive stages. The body was cruciform with dense hairs dorsolaterally. The larval period was completed in an average of 36.74 ± 0.49

TABLE 1. Life cycle of *Lymantria marginata* Wlk.

Sex	Developmental period in days (instars)								prepual period	pupal period	adult longevity	total life
	I	II	III	IV	V	VI	VII	Total				
Male	6.00 ±0.00	3.40 ±0.09	3.00 ±0.00	4.00 ±0.00	5.20 ±0.08	6.40 ±0.20	—	28.00 ± 0.12	2.00 ±0.00	8.00 ±0.00	8.46 ±0.20	46.40 ± 0.20
Female	6.00 ±0.00	3.56 ±0.05	3.56 ±0.05	3.78 ±0.07	4.44 ±0.09	6.56 ±0.09	13.78 ± 0.26	41.35 ±0.53	2.00 ±0.00	8.17 ±0.05	6.56 ±0.12	56.88 ± 0.49
Mean	6.00 ±0.00	3.50 ±0.04	3.36 ±0.03	3.85 ±0.04	4.64 ±0.05	6.50 ±0.06	13.78 ± 0.26	36.74 ±0.49	2.00 ±0.00	8.09 ±0.03	7.21 ±0.10	53.14 ± 0.43

days. The females had seven instars (41.55 ± 0.53 days) while six instars were observed in the case of male (28.00 ± 0.12 days) (Table 1).

During the laboratory experiment, the caterpillars fed actively between sunset and sunrise Part of the exuvia except the head was also eaten till the 5th instar. Maximum mortality of 43.27% was recorded in the 1st instar and 6.78% in the 2nd instar. No mortality was observed from 3rd to 6th instars. The last instar recorded 5.45% mortality only in females.

Pupa: The pupa was adecticous, obtect type with cylindrically spindle shaped body, characterised by an epicranial suture, setosed eyes, telescoping movement of abdominal segments, last pair of spiracles ill defined, and wing touching the anterior margin of IVth abdominal segment. The pupal period lasted for 8.09 ± 0.03 days with almost equal duration in both the sexes. The higher pupal weight in females than males is assigned by SINGH & GOEL (1985) to the accumulation of energy by the female for ovipositional activities.

Adult: An almost wet imago emerged out of the pupa with a brownish meconium. It rested for 2 to 3 hours and started fluttering as soon as the wings dried. The male moth was 33 mm across the wings whereas female with a wing span of 48 mm. The male moth was smaller and darker than the female and the sex ratio was 1♂: 2.25♀♀. Both thesexes had a longevity of 7.21 ± 0.10 days.

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CONTROL OF FRUITFLY OF BITTER GOURD USING SYNTHETIC PYRETHROIDS[2]

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In a field experiment conducted at the College of Agriculture, Vellayani, Karala, during the summer in 1982, the synthetic pyrethroids permethrin, fenvalerate and cypermethrin each at 100 g ai/ha and deltamethrin at 15 g ai/ha gave significantly better control of infestation by the melon fruitfly *Dacus cucurbitae* Coq on bitter gourd, than malathion at 500 g ai/ha when the crop was sprayed with the insecticides thrice on need basis. All the insecticides controlled the fruitfly upto 16 days after spraying. The insecticides had no effect on the flower formation and fruit set.

(Key words: bitter gourd, melon fly control. synthetic pyrethroid s)

INTRODUCTION

The fruitfly *Dacus cucurbitae* Coq (Trypetidae) is a major pest of bitter gourd *(Momordica charentia)*. DAS *et al.* (1968), NAGAPPAN *et al.* (1971) and MOTE (1975) evaluated the use of chlorinated hydrocarbons, organo-phosphate and carbamate insecticides against this pest. In the present paper results of studies on the effect of synthetic pyrethroid in controlling the fruit fly are presented.

MATERIALS AND METHODS

A field experiment was conducted at the College of Agriculture, Vellayani, Kerala, during the summer season of 1982 using a randomised block design with three replications. Seeds of *MC 23*, a popular variety of bitter gourd were sown in pits, 0.6 × 0.6 × 0.3 m at a spacing of 1.5 × 2.0 m between pits. Six pits in a plot of 6 m × 3 m formed one treatment. Two healthy seedlings were retained in each pit. Cultural operations recommended by CHAWHAN (1965) were followed. Plants in each treatment were trained on individual pandals 7 m long 4 m broad and 1.5 m heigh. The insecticide treatments were fenvalerate (Sumicidine), permethrin (Ambush) and cypermethrin (ripcord), as 0.01 and 0.02 per cent spray; (50 and 100 g ai/ha); deltamethrin as 0.0015 and 0.003 per cent spray (7.5 and 15 g ai/ha); malathion as 0.1 per cent spray (500 ml/ha); and an untreated control. The insecticides were applied on need basis 48, 78 and 102 days after sowing (DAS) at the rate of 500 litres of spray fluid per hectare using a hand compression sprayer in the morning hours without contaminating the adjacent plots. The untreated control plot was sprayed with water.

Results were assessed in terms of the percentage of the fruits damaged, by counting healthy and fly infested fruits first 9 DAS and then at weekly intervals. Presence of oviposition punctures, gummosis and rotting were taken as indicating infestation by the insect. Mature healthy fruits were harvested and yield recorded in weight. Total number

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TABLE 1. Mean percentage of bitter gourd fruits infested by *D. cucurbitae* under different insecticide treatments and occasions.

Insecticide and dosage (g ai/ha)	First spraying			Second spraying			Third spraying	
	9 DAS	16 DAS	23 DAS	9 DAS	16 DAS	23 DAS	9 DAS	16 DAS
Permethrin 50	41.32[b]	36.50[b]	13.23	14.38[b]	44.54[c]	58.10	72.14[c]	72.72[c]
,, 100	38.00[b]	36.90[b]	18.50	11.68[a]	33.81[b]	54.40	76.10[c]	71.90[c]
Fenvalerate 50	41.32[b]	36.00[b]	23.00	6.55[a]	41.08[b]	63.62	55.12[c]	57.20[c]
,, 100	28.00[a]	19.45[a]	18.80	6.70[a]	31.51[b]	55.80	55.40[c]	50.10[c]
Cypermethrin 50	40.80	32.80[b]	41.60[b]	28.90[b]	46.52[c]	62.02	67.70[c]	70.72[c]
,, 100	26.30[a]	18.86[a]	19.00	9.25[a]	31.80[b]	66.50	59.80[c]	51.64[c]
Deltamethrin 75	35.30	31.13[b]	21.00	28.65[b]	49.70[c]	58.35	64.40[c]	57.40[c]
,, 15	27.62[a]	22.12[a]	13.34	30.75[b]	48.20[c]	63.40	64.88[c]	57.88[c]
Malathion (check)	57.50[c]	48.90[c]	31.78	64.80[c]	59.10[c]	58.40	66.21[c]	68.16[c]
Untreated control	75.92	66.60	63.20	87.24	97.63	92.92	99.43	97.64
	**	**		**	**		**	**
CD (between treatments)	9.23	8.94	NS	14.75	16.35	NS	11.71	12.43
(After angular transformation)	not significant							

**Significant at 1% level. DAS—Days after spraying.

of female flowers formed and the fruits set under the different treatments during the entire crop season were also recorded. The data were analysed using 'F test.'

RESULTS AND DISCUSSION

All the synthetic pyrethroids were superior to malathion after the first spray and among them higher dose of cypermethrin, deltamethrin and fenvalerate were significantly more effective than the rest which among themselves were on par (Table 1). The effect of the insecticides in controlling the pest was not significant 23 DAS.

After the second spray all the synthetic pyrethroids were superior to the standard 9 DAS and the higher doses except that of deltamethrin were significantly more effective than the other treatments. The two doses of fenvalerate and the higher doses of cypermethrin and permethrin alone were superior to the standard 16 DAS. During the third round of spray all the insecticides including malathion were on par in controlling the pest on 9th and 16th DAS.

The results thus indicated that in general the synthetic pyrethroids gave better protection to bitter gourd fruits against fruitfly than malathion upto 16 DAS when sprayed upto 78 days after sowing.

There was no significant variation among the treatments in the number of female flowers formed and fruits set during the entire crop season (Table 2). Further, based on the yield data for the entire period from the plants under different treatments, all the insecticides were observed to reduce the fruit damage significantly over control. Higher doses of all the four synthetic pyrethroids were on par in their effect and superior to the standard malathion. Fenvalerate

TABLE 2. Mean percentage of fruit set and fruit damage on bitter gourd under different insecticide treatments.

Insecicides and damage (g ai ha)	Total no. of female flowers formed	Total number of fruits set	Mean percentage of		
			fruit set	fruit damage caused by fruit flies	Reduction in damage over control
Permethrin 50	70.66	60.00	83.71	50.66[b]	34.00
,, 100	94.00	83.33	88.01	37.33[a]	49.33
Fenvalerate 50	84.00	73.66	86.78	46.63[b]	40.03
,, 100	82.00	71.33	86.55	35.56[a]	51.10
Cypermethrin 50	78.00	66.33	83.08	53.08[b]	33.58
,, 100	77.66	68.00	85.30	38.31[a]	48.35
Deltamethrin 75	80.66	71.66	87.66	50.25[b]	36.41
,, 15	88.33	80.00	88.50	41.90[a]	43.76
Malathion 500	71.33	60.33	83.31	59.03[b]	27.33
Untreated control	69.66	60.33	85.66	86.66	—

at 100 g ai/ha was found as the most effective insecticide followed by permethrin and cypermethrin each at 100 g ai/ha and deltamethrin at 15 g ai/ha.

COLLINGWOOD (1979) had reported good control of fruitfly with decamethrin, fenvalerate and cypermethrin and permethrin was additionally found effective against the pest in the present studies. Since these insecticides did not affect cross pollination in this monoecious crop they can be judiciously used for the control of fruit-flies.

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EFFECT OF SOME PLANT MATERIALS ON THE DEVELOPMENT OF RICE MOTH, *CORCYRA CEPHALONICA* (STAINT.)

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Efficacy of a few plant materials as protectants of wheat against *Corcyra cephalonica* is discussed. Powdered rhizomes of *Acorus calamus* at 1 per cent level (W/W) provided complete protection in initial testing and after 2 months of storage. Powdered leaves of *Clerodendron inerme, Tylophora asthmatica, Justicia betonica* and *Cestrum nocturnum* were the next best in significantly reducing the adult emergence at 2 and 5 per cent levels. The other treatments were comparatively less effective. All the promising powders killed the first instar larvae before they could reach the next instar resulting in reduction of adult emergence.

(*Key words:* rice moth, *Corcyra cephalonica,* plant meterials)

Corcyra cephalonica is a serious Lepidoptera pest of stored cereals, oil seeds and processed food etc. Use of contact insecticides as sprays on storage structures and surface of stacks or as admixture with stored grain has been reported. Control measures using fumigants, pheromones, juvenile hormone analogues, tricalcium phosphate, triphenytin acetate and hempa have also been carried out (HODGES, 1979). A few reports are also available on the biological control of this pest. However, no work has been done on the use of plant products for controlling this pest. In the present investigation, a few plant materials having medicinal properties (NADKARNI, 1954) have been assayed against the larvae of *Corcyra cephalonica*.

Wheat samples were disinfested by keeping at -18°C for two weeks and were brought to equilibrium moisture content of 12 per cent by conditioning at 70 per cent RH maintained in a desiccator. Plant powders (60 mesh) were mixed with 20 g samples of wheat containing 10 per cent brokens to give concentrations of 1, 2 and 5 per cent (W/W). Treated samples were kept in 170 ml bottles and three replicates were maintained for each concentration and control. Separate controls were run for each plant powder. Freshly hatched larvae numbering 25 were introduced in each replicate. All the samples were incubated till the adult emergence at 29 ± 2°C temperature and 65–75 per cent RH. Observations were recorded on the first day of adult emergence and total number of adults emerged in different treatments as compared to controls. Treated samples of the four promising powders were stored at 29 ± 2°C temperature and 65–75 per cent RH to determine their efficacy after 2 months of storage. Assessment

TABLE 1. Effect of few plant powders on the development of *Corcyra cephalonica* larvae after 1day and 2 months of storage.

Plants	% Concn. (W/W)	Initial (1-day)		2- months	
		Day of emergence (a)	Total adults emerged (b)	Day of emergence (a)	Total adults emerged (b)
Acorus calamus	0	40.00	48	40.00	42
	1	—	0	—	0
	2	—	0	—	0
	5	—	0	—	0
Clerodendron inerme	0	40.00	44	42.00	33
	1	50.00	4	48.00	5
	2	53.00	1	54.00	4
	5	—	0	55.00	1
Tylophora asthmatica	0	46.00	37	44.00	42
	1	54.00	8	52.00	8
	2	54.00	2	54.00	7
	5	—	0	—	0
Justicia betonica	0	40.00	28	40.00	33
	1	43.00	13	42.00	9
	2	43.00	11	42.00	8
	5	48.00	4	43.00	8
Cestrum nocturnum	0	38.00	32		
	1	39.33	15	—	—
	2	41.00	17		
	5	44.33	5		
Withania somnifera	0	39.00	45		
	1	43.00	21		
	2	44.33	19	—	—
	5	47.00	11		
Peganum harmala	0	39.00	32		
	1	41.00	23		
	2	43.33	22	—	—
	5	45.33	18		
Embelia ribes	0	38.33	30		
	1	39.67	22		
	2	40.67	23	—	—
	5	43.00	9		

a—Vaules are means from three replicates.
b—Total number from three replicates each infested with 25 first instar larvae.

of efficacy was based on the total number of adults emerged from the replicates and per cent inhibition of adult emergence. Per cent inhibition is represented as total adult emergence in treatments taken as percentage of untreated controls, and was calculated as follows:

$$\text{Per cent inhibition} = 100 - \frac{t}{c} \times 100),$$

where 't' and 'c' represent total number of adults emerged in treatments and controls respectively.

Results on the effect of powders on the total adult emergence and day of first emergence are indicated in Table 1. It was observed that rhizomes of *A. calamus* even at 1 per cent level killed all the larvae in their early stages thereby completely reducing the adult emergence. Leaves of *C. inerme* and *T. asthmatica* were the next best in reducing the adult emergence significantly over controls. Powders of *C. nocturnum* and *J. betonica* were promising at 5 per cent level only, while powders of *Withania somnifera* rhizomes, *Peganum harmala* seed, and *Embelia ribes* berries were comparatively less effective in reducing the adult emergence. A few plant materials prolonged the duration of larval stages in comparison to controls.

Four of the five promising plant materials were evaluated for their efficacy after 2 months of storage. It was found that *A. calamus* rhizomes exhibited the same effectiveness and provided 100 per cent kill of the first instar larvae. The other three plants also retained their efficacy after storage (Table 1).

While comparing the per cent inhibition of adult emergence (Table 2), it was observed that *A. calamus* rhizomes even at 1 per cent level provided complete inhibition followed by leaves of *C. inerme*, *T. asthmatica*, *J. betonica* and *C. nocturnum* which also inhibited the

TABLE 2. Percentage inhibition of adult emergence of *C. cephalonica* in treated wheat at different storage intervals.

Treatments	Initial (1 day) % conc. (W/W)				2 month % conc. (W/W)			
	1	2	5		1	2	5	
A. calamus	100.00	100.00	100.00		100.00	100.00	100.00	
C. inerme	90.90	97.80	100.00		84.45	87.88	96.97	
T. asthmatica	78.40	94.60	100.00	CD at	81.00	82.68	100.00	CD at
J. betonica	54.00	60.67	85.70	5%	72.73	75.76	75.76	5%
C. nocturnum	53.00	78.20	84.00	between	—	—	—	between
W. somnifera	53.33	57.78	75.55	Conc.	—	—	—	Conc.
P. harmala	28.00	31.25	43.75	52.83	—	—	—	-16.24
E. ribes	26.67	23.33	70.00		—	—	—	
	CD at 5% Between Treatments -44.08				CD at 5% Between Treatments -27.99			

Statistical analysis done by ANOVA employing two-tailed test.
All the values are means of three replicates.

adult emergence by more than 70 per cent after 2 months of storage.

The prolonged protection offered by the powdered rhizomes of *A. calamus* is because of its known insecticidal properties. MOOKHERJEE & GOVIND (1959), PAUL *et al.* (1965) and TEOTIA & PANDEY (1979) have also discussed the insecticidal activity of powder and extracts against insect pests of storage. PANDEY *et al.* (1976) and CHANDER & AHMED (1983) have also reported the grain protectant properties of *A. calamus* rhizomes for prolonged period against important insect pests of storage. Hence such promising plant products can be effectively used to protect stored wheat from insect infestation as such plants are safer.

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BRIEF COMMUNICATION

FIELD TRIAL OF FENITROTHION FOR THE CONTROL OF MALARIA

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During the epidemic of malaria in Saidpur village of Gurgaon District, an epidemiological study was carried out. Pre- spray and postspray survey showed that fenitrothion spray led to decline of the parasite rate from 83.3% to 1.8%. No *Plasmodium falciparum* cases were recorded after spray.

(Key words: malaria, fenitrothion, spray, *Anopheles culicifacies)*

In India, of all the vector borne diseases, malaria still causes most concern. In recent years DDT and BHC have failed to control malaria in many states of India, because of the development of resistance in the vector, *Anopheles culicifacies*, to these insecticides. Fenitrothion shows promise as a substitute for chlorinated insecticides in the control of malaria. Selective application of fenitrothion was carried out in central Java (BANG *et al.*, 1981). A village-scale field trial of fenitrothion was carried out against *Anopheles aconitus* in Indonesia (JOSHI *et al.*, 1977; PRADHAN *et al.*, 1979). Fenitrothion was also evaluated in antimalaria programme near Kisumu, Kenya (FONTAINE *et al.*, 1978). It was also used as residual spray in Garbora, Gujrat (WATTAL *et al.*, 1978).

The present trial was carried out in Saidpur village, about 15 km from Gurgaon city. An epidemic of malaria occurred in this village in September 1983. The trial village comprised 80 human dwellings, 23 cattle sheds and a population 702. The houses are small and constructed of mud and stones with thatch roofs. A fenitrothion 40% water dispersible powder (wdp) formulation was applied at a target dosage of 100 mg/sq feet with Stirrup sprayers fitted with pressure gauges and nozzle tips, having initial discharge rate of 740—857 ml/minute. The interior walls and ceiling of the houses were sprayed to a height of 2m as well as undersides of furniture and horizontal surface.

Cattle shelters and all out-houses were also sprayed. Spraying was done by two squads, each with five spraymen and a Sanitary Supervisor. Only one round of Fenitrothion residual spray was applied. The following types of mosquito collection were made : nocturnal (6 pm to 10 pm) resting density indoors and outdoors : and diurnal (6.30 am to 8.30 am) resting in human dwelling and cattle sheds. Density of mosquitoes were reported as number per man–hour. The collection was made by one Insect Collector with aspirator tube and torch light.

Results of epidemiological and entomological studies are shown in Table 1. The total number of malaria cases

TABLE 1. Epidemiological and entomiological observations in Saidpur village before and after fenitrothion spray.

Parameter	pre-spray	post-spray	% change
No. of slides examined	72	211	+56.1
No. positive	60	4	—93.33
Species of parasite			
Plasmodium vivax	58	4	—93.10
Plasmodium falciparum	2	—	—50.00
Parasite rate	83.3%	1.8%	—81.5
Vector density *(per man hour)*			
Anopheles culicifacies	45	4	—91.11

were reduced by 93.3% after spray. Reduction in *Plasmodium vivax* cases based on pre spray was 93.1%. No case of *Plasmodium falciparum* was recorded after fenitrothion spray. Parasite rate also decreased from 83.3% to 1.8%. There was 91.1% decline in *Anopheles culicifacies* density in this village after spray operations. The trial showed that fenitrothion could effectively control the malaria and malaria vector *Anapheles culicifacies*.

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BRIEF COMMUNICATION

BRACHYMERIA EXCARINATA GAHAN (HYMENOPTERA: CHALCIDIDAE) AS PUPAL PARASITOID OF *CALOPEPLA LEAYANA* LATR. IN KERALA, INDIA: A NEW RECORD

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Brachymeria excarinata Gahan is newly recorded as a pupal parasitoid of *Calopepla leayana* Latreille (Coleoptera: Cassididae), a pest of *Gmelina arborea* (Verbenaceae).

(Key words: Brachymeria excarinata, Calopepla leayana, Gmelina arborea, Pediobius elasmi)

Calopepla leayana Latreille (Coleoptera : Cassididae) is a pest of *Gmelina arborea* (Verbenaceae), a tree of forestry importance. A chalcid *Brachymeria excarinata* Gahan is recorded here as a new pupal parasitoid of *Calopepla leayana* Latr.

Late larvae and pupae of *Calopepla leayana* were collected from leaves of *G. arborea* in the KFRI campus and examined. The collections were made during the first week of Nov. 1984 and first to third week of July 1985. In the first collection 40 out of 55 pupae (72%) and in the second collection 100 out of the 164 pupae (60%) were parasitised by *B. excarinata*. The adult parasite emerged through a hole on the mid-dorsal side of the host pupa. Only one parasite emerged from each pupa.

B. excarinata is widely distributed (GAHAN, 1925; GARTHWAITE, 1936; CHERIAN *et al.*, 1939). It is known to attack members of the Lepidopteran families, Eucosmidae, Gelechiidae, Hesperiadae, Pyralidae, Tortricidae, Xyloryctidae and Yponomeutidae (CHERIAN *et al.*, 1938; JOSEPH *et al.*, 1973; NARENDRAN *et al.*, 1975). Although it is polyphagous there are no reports of *B. excarinata* parasitising insects of other orders. This is the first report of the species from an order other than Lepidoptera. Parasitism of *C. leayana* by *Brachymeria* was reported earlier by ATKINSON (1936), as well as by GARTHWAITE (1936), but the species were not determined.

In addition to *B. excarinata* another parasite, *Pediobius elasmi* (Ashmead) (Eulophidae) was obtained from the first collection (Nov. 1984). Only one out of the 55 pupae was parasitised and 13 parasites emerged from a single pupa.

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BRIEF COMMUNICATION

LIFE TABLE AND INTRINSIC RATE OF INCREASE OF *COTESIA DIURNII* CHALIKWAR AND RAO (HYMENOPTERA : BRACONIDAE), A LARVAL PARASITOID OF *EXELASTIS ATOMOSA* WALS.

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Cotesia diurnii Chalikwar and Rao, a larval parasitoid of *Exelastis atomosa* Wals. had an average oviposition period 5.8 days, an average longevity of 7.5 days and produced an average progeny of 61.6 individuals with sex ratio (♂ : ♀) 1.365:1. The intrinsic rate of increase was 0.158 and population multiplied 25.99 times in mean generation time (T) 20.61 days.

(Key words: life table, intrinsic rate of increase, *Cotesia diurnii)*

In pest management essential objects are the estimation of rate of growth of pests and their natural enemies. *Cotesia* Cameron (1891) is one of the largest genera comprising about 1500 to 2000 species and most of which are parasitoids of the larvae of Macrolepidoptera. *C. diurnii* is a larval parasitoid of *E. atomosa*. The effectiveness of hymenopterous species in terms of their intrinsic rates of natural increase have been assessed by CHUNDURWAR (1975), BASARKAR & NIKAM (1981), NIKAM & SATHE (1983) & SATHE & NIKAM (1984).

Cultures of hosts and parasitoids were maintained at laboratory conditions (24±1°C, 55–60% R H). Newly emerged adults of *C. diurnii* were exposed to 3–4 day old 40 *E. atomosa* larvae. Daily different lots of hosts were provided to the parasitoids till their death. The hosts and parasitoids were fed with pigeonpea pods and 20% honey respectively. Fecundity was determined by progeny production. The life tables were constructed from the number of individuals alive at each age interval. The life table statistics was prepared by using BIRCH'S (1948) formula as elaborated by HOWE (1953) and WATSON (1964) :

$$\Sigma\, e^{-r_m.x}\, l_x m_x = 1$$

Average duration of immature stages was 18 days. Longevity of ovipositing females averaged 5.8 (range 5 to 7) days. The progeny produced averaged 61.6 individuals (range 60 to 65). The offsprings (♂ : ♀) averaged 1.365:1 (range 1.214:1 to 1.541:1). Table 1 represents the life table statistics. Maximum mean progeny production per day m_x was 9.70 on the 3rd day.

$$T_c = \frac{\Sigma\, l_x m_x x}{\Sigma\, l_x m_x} = \frac{542.62}{25.99} = 20.87$$

where 'T_c' is arbitrary 'T'

$$r_c = \frac{\log_e R_o}{T_c} = \frac{\log_e 25.99}{20.87} = 0.156$$

where 'r_c' is arbitrary 'r_m'

TABLE 1. Life table statistics of *C. diurnii*.

Pivotal age (days) x	proportional live at age x l_x	No. of female progeny/female m_x	$l_x m_x$	$l_x m_x$ x
1 to 18 days immaturn stages				
19	1.00	3.70	3.70	70.30
20	1.00	5.40	5.40	108.00
21	1.00	9.70	9.70	203.70
22	1.00	4.50	4.50	99.00
23	1.00	2.00	2.00	46.00
24	0.90	0.70	0.63	15.12
25	0.60	0.10	0.06	1.50
			Σ25.99	Σ542.62

Now Arbitrary 'r_m' s(r_e) are 0.19 and 0.15.

$$\Sigma e^{-r_m . x} l_x m_x = 1$$

$\therefore r_m = 0.158$ (figure).

$= r_m = e^{0.158}$:

$$T = \frac{\log_e 25.99}{0.158} = 20.61 \text{ days.}$$

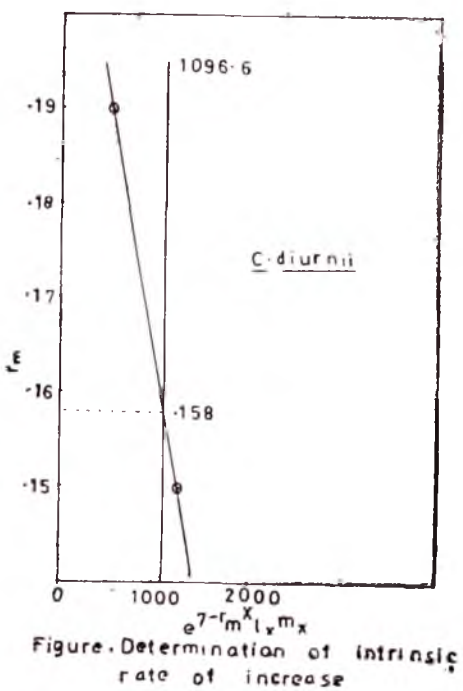

Figure. Determination of intrinsic rate of increase

The innate capacity for increase was found to be 0.158 (Fig. 1) per female per day and population multiplied to 25.99 times in mean generation time of 20.61 days.

Life table studies of hymenopterous parasiloids have been conducted by CHUNDURWAR (1975), BASARKAR & NIKAM (1981), NIKAM & SATHE (1983) & SATHE & NIKAM (1984). The components in these studies were developmental period' fertility and survival. The intrinsic rate of natural increase (r_m) was the main focus of this study because it has been used as a bioclimatic index for rating the parasitoids. In the present species, the intrinsic rate of increase was 0.158 and population would multiply to 25.99 in a generation time of 20.61 days at laboratory conditions.

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BRIEF COMMUNICATION

INSECTS AND MITES ASSOCIATED WITH *CHROMOLAENA ODORATA* (L.) R. M. KING AND H. ROBINSON (ASTERACEAE) IN KARNATAKA AND TAMIL NADU

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The results of a field survey conducted in Karnataka and Tamil Nadu, India, on the insects and mites associated with *Chromolaena odorata* are presented.

(Key words: insects, mites, association, *Chromolaena odorata)*

Chromolaena odorata (L.) R. M. KING & H. ROBINSON is a perennial weed of the neotropics, but it has become a serious problem in plantation crops, forest areas, waste lands and pastures. A number of insects are known to be associated with *C. odorata* in Sumatra (NAEZER & MEER MOHR, 1953) in Trinidad (CRUTTWELL, 1968) and in the neotropics (CRUTTWELL, 1974). *Aphis spiraecola* Patch was found infesting young shoots in India and Sabah (BENNETT & RAO, 1968) and in Ghana (HALL *et al.*, 1972). JOY *et al.* (1979) reported occurrence of *A. spiraecola, Brachycaudus helichrysi* (Kaltenbach) and *Aphis fabae* Scopoli in Kerala. RAMANI & HAQ (1983) recorded oribatid mites, *Eremulus flagellifer* Berlese, *Lamellobates palustris* Hammer, *Paralamellobates bengalensis* BHADURI & RAYCHAUDHURI, *Pelokylla malabarica* CLEMENT & HAQ, *Scheloribates* sp. and *Galumna* sp. at Calicut. IHEAGWAM (1983) reported *Aphis gossypii* Glover, *Anoplocnemis curvipes* (Fabricius), *Zonocerus variegatus* (Linnaeus) and an unidentified mealybug on this plant in Nigeria.

In the present study the results of a field survey conducted in Karnataka and Tamil Nadu on the insects and mites associated with *C. odorata* are presented.

Chrysodeixas chalcites (Esper) (Noctuidae): It is a pest of vegetable and pulse crops and also a minor pest of jute and sunnhemp. It is cosmopolitan in distribution. The caterpillar, a green semilooper, was found feeding on the leaves of *C. odorata* at Coimbatore.

Hyposidra talaca (Walker) (Geometridae): The caterpillar is brown and is known to attack mango, cacao, rose, sweet potato and millets (NAIR, 1975). It was found feeding on the leaves of *C. odorata* at Bangalore.

Archips micaceanus (Walker) (Tortricidae): The small caterpillars of this moth have been found webbing the tender leaves of *C. odorata* and feeding

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on them at Bangalore. It is a polyphagous insect sometimes attaining a pest status on grape vine (PUTTARUDRIAH *et al.*, 1960).

Orthezia insignis Browne (Ortheziidae): It is an accidentally introduced insect to India. It has been severely defoliating *C. odorata* and lantana in pockets in Anaimalai Hills and Bangalore area. Often heavy sooty mold accompanies the attack by this insect. This insect is also known to attack many fruit and vegetable crops and coffee (HILL, 1975).

Saissetia sp. (Coccidae): This scale insect is a common pest of many crops. Only a few were collected on *C. odorata* in Bangalore.

Coccostrephus minutus (Fabricius) (Membracidae): Adults of this membracid are common on *C. odorata* at Bangalore and Coimbatore.

Leptocentrus sp. (Membracidae) : Adults of this insect were found on *C. odorata* at Bangalore and Coimbatore. It is not as common as *Coccostrephus minutus* on *C. odorata*.

Neorthacris acuticeps (Bolivar) (Pyrgomorphidae): This wingless grasshopper is quite common on the leaves of *C. odorata* at Coimbatore. It is a pest of mulberry in South India and also feeds on rose and lantana plants (SINGH & KEVAN, 1965).

Tetranychus sp. (Tetranychidae) : Mites of the genus *Tetranychus* are common pests of beans, vegetables and other crops. This unidentified species was found to attack the weed during summer.

Polyphagotarsonemus latus (Banks) (Tarsonemidae): It is also cosmopolitan in distribution and attacks many economically important crops like tea, cotton jute, tomato, pepper, avacado, citrus, mango, and ornamentals (HILL, 1975).

Calacarus sp.* (Eriophyidae): This is a vagrant mite which affects tender shoots. The scorched shoots become stunted and stop growing. The affected leaves become distorted and stunted. It is the first time this mite has been recorded on *C. odorata*. Since it retards the growth of tender shoots, the mite may prevent flowering of the affected shoots and this aspect needs to be studied during the months of November-December.

Most of the insects and mites *(Tetranychus* sp. and *P. latus)* reported here are polyphagous and pests of many crops and they are primarily using *C. odorata* as an alternate host. With the exception of *O. insignis* none others were causing significant defoliation.

Most eriopyid mites are restricted in their host range and there is a good possibility that *Calacarus* sp. could be used in the biological control of *C. odorata*, if it proves to be host specific. CRUTTWELL, (1977) demonstrated the host specificity of another eriophyid mite, *Acalitus adoratus* Keifer and recommended that it could be used in biological control of *C. odorata*.

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* Preliminary studies indicate that this is an undescribed species. The mite was first observed in Bangalore. Dr. G. P. ChannaBasavanna and Mr. N. H. Lakkundi will be describing this species in due course.

for identification of moths and mites, respectively. The senior author thanks the Council for International Exchange of Scholars, U S A, and the U S Educational Foundation in India for providing the Fulbright fellowship which enabled him to conduct this study.

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RESOURCE UTILIZATION DIVERGENCE AMONG TEN CLOSELY RELATED STRAINS OF *DROSOPHILA*

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Ten morphologically indistinguishable strains of five different species belonging to orbital sheen complex of the *nasuta* subgroup of *Drosophila* have been examined with respect to their ecogenetic differentiation using different media with different sugars. Intraspecific competition experiments have been made utilising these strains on wheat cream agar media containing either sucrose or glucose or fructose, Media with sucrose appear to be more suitable than the other two with respect to the parameters of 'adaptedness' assessed. These strains have demonstrated significant differences in their response to a common type of medium. These forms have shown certain degree of ecological differentiation and probably they represent different facets of evolutionary divergence. The implications of these findings are discussed.

(Key words: Drosophila, sugar, adaptedness, ecogenetics, evolution)

INTRODUCTION

Drosophila is a potent eukaryotic system to explore many facets of ecogenetics. Of late, population geneticists are using *Drosophila* as a representative system to understand genetic basis of ecological differentiation at the level of populations and species (PARSONS & SPENCE, 1981; POWELL & ANDJELKOVIC, 1983; TAYLOR & CONDRA, 1983).

Nasuta subgroup of *Drosophila* is an assemblage of morphologically almost identical forms with various degrees of reproductive isolation (WILSON *et al.*, 1969). The orbital sheen complex of the *nasuta* subgroup includes *D. sulfurigaster sulfurigaster, D. s. albostrigata, D. s. bilimbata, D. s. neonasuta, D. pulaua* and *D. nixifrons* (NIRMALA & KRISHNAMURTHY, 1974). These are morphologically indistinguishable from one another. Various investigators have analysed the extent of genetic differentiation and the possible evolutionary relationships among these forms of *Drosophila*. This has been done with reference to mating behaviour (SPIETH, 1969), inter and intraspecific hybridization (RANGANATH & KRISHNAMURTHY, 1976), enzyme variation (RAMESH & RAJASEKARASETTY, 1980), fixed inversion differences (RAJASEKARASETTY, *et al.*, 1980) and the differences in heterochromatin content (RANGANATH & USHAKUMARI, 1984).

For a coherent evolutionary analysis of species or of populations an integration of genetics at the levels of populations and ecology is needed. In view of this the present project was undertaken to investigate the extent of ecogenetic differentiation among the morphologically identical, phylogenetically and taxonomically closely placed

forms of the orbital sheen complex of the *nasuta* subgroup of *Drosophila*. This report deals with the relative performance of these forms of *Drosophila* in different media containing different types of sugars.

MATERIALS AND METHODS

The strains of *Drosophila* used in this experiment are as follows: *D. sulfurigaster sulfurigaster* 30.19.8 obtained from Texas, U S A; *D. s. sulfurigaster*, P-11 Port Moresby, Papua New Guinea; *D. s. albostrigata* W-3 Singapore; *D. s. albostrigata* S-11 Sandakan, Sabah, Malaysia; *D. s. bilimbata* GUM-8 Guam; *D. s. bilimbata* HNL-III Hawaii; *D. s. neonasuta* Polymorphic Mysore, India; *D. s. neonasuta*, Monomorphic Mysore, India; *D. pulaua* V-6, Kuching, Sarawak, Malaysia; *D. pulaua* S-18, Sandakan, Sabah, Malaysia; Except *D. s. neonasuta* strains, all other strains were provided by Prof. O. KITAGAWA, Japan.

Experiments were started with 25 individuals (12 males and 13 females) in three different media that is wheat cream agar medium containing either sucrose or glucose or fructose. The concentration of sugar used is 5 per cent. The populations were maintained at 21°C by the serial transfer technique of AYALA (1965). The adult flies were introduced in quarter pint milk bottles containing wheat cream agar medium. Once in seven days they were etherised, counted and transferred to fresh media bottles. When the emergence began in the bottles where the adult flies have deposited eggs, the newly emerged flies were etherised, counted and added to the bottles with the adult flies. Each bottle is discarded after four weeks. The adult ovipositing flies were thus always in a single bottle while other bottles contained different preadult stages of the flies. Four replicates were made for each experiment. The mean values for population size, productivity, mortality and flies per bottle (four parameters of adaptedness) were calculated for twelve weeks. We have used the mean square error from the analysis of variance to ascertain both interstrain and interspecific differences in different media.

RESULTS AND DISCUSSION

Drosophila species utilize a variety of sugar sources (HASSETT, 1948; TAYLOR & CONDRA, 1983). The extent to which populations are differentiated in relation to such resources is not known and is worthy of detailed investigation. BAUMBERGER (1919) and HASSETT (1948) have demonstrated that sugar was a dietary requirement and have given the preliminary data on the role of different sugars on the biology of *Drosophila*. Similarly, RAMACHANDRA & RANGANATH (1984) have made an attempt to report the differences in the performance of *D. melanogaster*, *D. ananassae*, *D. nasuta nasuta* and *D. n. albomicana* on media with different types of sugars. PARSONS & SPENCE (1981) have shown resource utilization divergence among six closely related *Drosophila* species of *melanogaster* subgroup in the utilization of ethanol and acetic acid as energy sources. In the present experiment, five closely related forms of *Drosophila* have been exposed to three different types of sugars, namely sucrose, glucose and fructose and the findings are presented in this paper. These experiments have been made more for comparative purposes than to make inferences about natural populations.

Populations of organisms must live and reproduce in order to be designated as 'adapted'. Adaptedness refers to the ability of the carriers of a genotype or a group of genotypes to survive and reproduce in a given environment (DOBZHANSKY, 1968). In the laboratory populations, four different facets of adaptedness can be obtained, namely, population size, productivity, mortality and flies per bottle. Population size is measured in terms of average population size it maintains during the experimental period. Productivity is the extent of reproductive potential, measured in terms of new born flies every week. Mortality is the death rate of flies during every

week and flies per bottle gives us the information with regard to the average number of flies present in each bottle during the experiment. These may be taken as satisfactory statistics to estimate and to compare the performance of different strains of *Drosophila* (AYALA, 1965). This provides means for comparing the overall biological performance of one gene pool with another, where both are maintained under similar or defined environmental conditions.

The adaptedness of different strains of *Drosophila* in the media with sucrose is presented in Table 1. Only *D. s. bilimbata* shows significant interstrain differences while the differences between the strains of other species are insignificant. The differential ability of different species to exploit the sucrose media differently is striking. Polymorphic strain of *D. s. neonasuta* has achieved the maximum adaptedness while HNL III strain of *D. s. bilimbata* has secured the least values. Similarly Table 2 gives the mean values for the four parameters of adaptedness where the flies cultured in the media containing glucose. Interestingly, except *D. pulaua*, all other forms show significant interstrain differences with regard to their abilities to utilize the media containing glucose. In this set up, the polymorphic strain of *D. s. neonasuta* has attained the highest values for the parameters assessed while S-18 strain of *D. pulaua* has the minimum values. The ranking for the 10 strains of *Drosophila* in the glucose media is as follows: *D. s. neonasuta* (Polymorphic) > *D. s. neonasuta* (Monomorphic) > *D. s. albostrigata* (W-3) > *D. s. sulfurigaster* (30.19.8) > *D. s. bilimbata* (GUM-8) > *D. s. albostrigata* (S-11) > *D. s. sulfurigaster* (P-11) > *D. s. bilimbata* (HNL-III) > *D. pulaua* (V-6) > *D. pulaua* (S-18). The S-18 strain of *D. pulaua* has the lowest reproductive potential and its population thrives for twelve weeks only

TABLE 1. Mean values (for four replicates) along with standard errors for population size, productivity, mortality and flies per bottle in the media containing sucrose for ten different strains of *Drosophila*.

Species/parameters	*population size	productivity	mortality	flies per bottle
Drosophila sulfurigaster (3.019.8)	91.79 ± 4.30	65.35 ± 2.49	53.21 ± 1.44	28.25 ± 1.32
D. s. sulfurigaster (P-11)	91.38 ± 14.90	62.13 ± 9.99	46.75 ± 6.37	28.12 ± 4.58
D. s. albostrigata (W-3)	101.67 ± 13.39	60.33 ± 7.08	45.95 ± 5.89	31.78 ± 4.12
D. s. albostrigata (S-11)	82.67 ± 15.10	53.50 ± 9.82	45.73 ± 8.11	25.44 ± 4.65
D. s. bilimbata (GUM-8)	91.19 ± 2.49	56.15 ± 4.49	42.23 ± 3.85	28.06 ± 0.77
D. s. bilimbata (HNL-III)	37.02 ± 8.06	18.88 ± 4.76	16.84 ± 4.17	11.39 ± 2.48
D. s. neonasuta (polymorphic)	187.90 ± 4.93	119.63 ± 2.80	86.93 ± 2.67	57.81 ± 1.51
D. s. neonasuta (monomorphic)	154.73 ± 7.31	99.43 ± 2.81	71.48 ± 8.16	47.61 ± 2.24
D. pulaua (V-6)	83.92 ± 5.60	52.45 ± 4.95	40.02 ± 1.38	25.82 ± 1.99
D. pulaua (S-18)	68.00 ± 2.84	50.28 ± 3.47	39.30 ± 1.55	20.92 ± 0.87

* Analysis of variance test: $F = 21.63$; $df = 9, 30$; $P < 0.01$.

TABLE 2. Mean values (for four replicates) along with standard errors for population size productivity, mortality and flies per bottle in the media containing glucose for ten different strains of *Drosophila*.

Species/parameters	*population size	productivity	mortality	flies per bottle
Drosophila sulfurigaster (30.19.8)	58.61 ± 4.24	28.40 ± 2.23	21.59 ± 2.32	18.03 ± 1.30
D. s. sulfurigaster (P-11)	36.19 ± 1.75	16.20 ± 1.07	14.36 ± 1.85	11.13 ± 0.54
D. s. albostrigata (W-3)	85.54 ± 5.15	43.08 ± 2.99	31.14 ± 2.74	26.32 ± 1.58
D. s. albostrigata (S-11)	38.03 ± 6.38	16.38 ± 3.77	12.18 ± 3.99	9.59 ± 1.91
D. s. bilimbata (GUM-8)	52.73 ± 3.97	21.55 ± 1.39	17.07 ± 0.70	16.23 ± 1.22
D. s. bilimbata (HNL-III)	31.15 ± 3.11	10.78 ± 1.52	10.72 ± 1.31	10.51 ± 0.95
D. s. neonasuta (Polymorphic)	134.73 ± 4.25	56.58 ± 1.15	30.59 ± 0.90	41.45 ± 1.30
D. s. neonasuta (Monomorphic)	108.25 ± 1.48	47.90 ± 1.66	27.20 ± 1.81	33.31 ± 0.45
D. pulaua (V-6)	28.38 ± 3.71	10.48 ± 2.26	9.12 ± 1.56	8.73 ± 1.14
D. pulaua (S-18)	15.75 ± 1.03	5.20 ± 0.77	7.18 ± 0.40	5.29 ± 0.15

*Analysis of variance test: $F = 93.40$; $df = 9.30$; $P < 001$.

TABLE 3. Mean values (for four replicates) along with standard errors for population size, productivity, mortality and flies per bottle in the media containing fructose for ten different strains of *Drosophila*.

Species/parameters	*population size	productivity	mortality	flies per bottle
D. s. sulfurigaster (30.19.8)	37.90 ± 5.41	15.65 ± 2.41	10.32 ± 2.51	11.66 ± 1.66
D. s. sulfurigaster (P-11)	7.27 ± 1.26	0.28 ± 0.28	2.88 ± 0.24	2.75 ± 0.54
D. s. albostrigata (W-3)	60.50 ± 3.94	23.88 ± 1.18	16.13 ± 1.42	18.62 ± 1.21
D. s. albostrigata (S-11)	32.01 ± 6.54	23.44 ± 6.78	22.77 ± 5.42	11.35 ± 2.66
D. s. bilimbata (GUM-8)	64.67 ± 4.24	28.63 ± 0.59	21.27 ± 0.44	19.90 ± 1.31
D. s. bilimbata (HNL-III)	21.98 ± 1.82	8.74 ± 1.93	9.33 ± 1.00	7.16 ± 0.50
D. s. neonasuta (Polymorphic)	69.10 ± 7.36	26.13 ± 4.03	18.68 ± 4.46	21.26 ± 2.26
D. s. neonasuta (Monomorphic)	79.96 ± 4.22	28.45 ± 1.79	19.05 ± 0.89	24.60 ± 1.30
D. pulaua (V-6)	64.56 ± 1.28	37.25 ± 2.40	30.61 ± 2.00	19.87 ± 0.39
D. pulaua (S-18)	49.25 ± 2.54	26.23 ± 2.69	19.96 ± 2.69	15.16 ± 0.78

* Analysis of variance test: $F = 28.38$; $df = 9.30$; $P < 0.01$.

in the media with glucose. The adaptedness evinced by different strains of *Drosophila* under investigation in the media with fructose is presented in Table 3. Except *D. s. neonasuta* and *D. pulaua* others have significant interstrain differences. Statistical comparison has revealed that the monomorphic strain of *D. s. neonasuta* tops the list while the P-11 strain of *D. s. sulfurigaster* has the least mean values for all the four components of adaptedness. It was noticed that the P-11 strain of *D. s. sulfurigaster* manages to survive just for ten weeks and fails to breed continuously in the media with fructose. The analysis of adaptedness evinced by different species under study reveals that *D. s. sulfurigaster*, *D. s. albostrigata*, *D. s. bilimbata* and *D. s. neonasuta* have better performance in the media with sucrose followed by the media with glucose and fructose. On the other hand, *D. pulaua* has the following order of preference: sucrose > fructose > glucose.

The strain which maintains larger population size may be said to be performing better from biological point of view than the strain having a smaller population size. There exist notable differences in the biological performance of the five species under study in any one type of media. The members of the orbital sheen complex of the *nasuta* subgroup have reacted differently as evidenced by their adaptedness, to a common nutritional resource. These findings suggest that there exist some degree of ecological differentiation among these closely related forms of *Drosophila*.

Thus, the members of the orbital sheen complex of the *nasuta* subgroup, eventhough they are morphologically totally identical and phylogenetically and taxonomically closely related, have manifested sufficient differentiation at ecogenetic level, under laboratory conditions. Hence, it appears that the morphophenotypic similarity of these species and their ecogenetic phenotypes have no correspondence to one another and probably they represent different facets of evolutionary divergence.

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SCANNING ELECTRON MICROSCOPIC STUDIES OF *ANNECTACARUS LONGISETOSUS* (ACARI : LOHMANNIIDAE)

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External anatomy of *Annectacarus longisetosus* was studied with scanning electron microscope which yielded many structural details.

(Key words: scanning electron microscopic studies, *Annectacarus longisetosus)*

INTRODUCTION

Scanning electron microscope studies (SEM) (WOOLLEY, 1970) provided many useful and important facts regarding taxonomy of oribatid mites through clarification of such aspects as chaetotaxy. SINGH & WALLWORK (1980) studied some important characters of lower and higher oribatids under SEM. The present paper is based on SEM photographs of *Annectacarus longisetosus* which is a common soil-inhabiting oribatid of eastern and north eastern India.

METERIALS AND METHODS

Live mites were extracted from the soil and litter collected from the canopy base of Jack fruit tree, by means of Tullgren funnels in distilled water. The materials were examined carefully under a stereoscopic binocular and *A. longisetosus* were sorted out for further processing. The specimens were fixed in 1% glutaraldehyde (SABATINI *et al.*, 1963) in 0.1 M phosphate buffer (pH 7.2) at 4—5°C for one hour. These were washed first in buffer and finally in distilled water at room temperature The specimens were then dehydrated in graded ethanol and placed over cover glasses of 12 mm diameter by glue after complete dehydration and fixed over aluminium stubs. Before SEM observation the specimens were gold coated in a Denton rotar evaporator DV–502 model and viewed in the secondary electron emissive mode in SEM (PSEM 500 of Philips) using 12–25 KV. The SEM images were recorded on low speed films.

RESULTS AND DISCUSSION

SEM microphotograph thus obtained not only verified many of the previons observations made under optical microscope by BHATTACHARYA *et al.* (1974) but also yielded further clarity of structures and some new details. The dorsolateral aspect of the notogaster shows presence of regular polygonal reticulations (Figs. 1, 2) but the dorsal surface is rather rugged without prominent polygonal reticulations. The rostral setae are not inserted on a transverse ridge (Fig. 3) as has been previously reported by BHATTACHARYA *et al.* (1974). On the other hand seta *exa* is inserted dorsally on the prodorsal ridge and is thicker and coarsely barbed compared to lamellar hair (Fig. 4). The most important clarity which has been revealed by the three dimensional photograph is in the position and shape of the pseudostigmatic organ. The bothridium is situated at

considerable distance from the prodorsal ridge and is not adjacent to the ridge as has been erroneously shown by BHATTACHARYA *et al.* (1974) (Fig. 4). The sensillus which is pectinate, has nine to ten branches and the outer margin has three fine barbs. Notogastral satae are of various shapes and size (Fig. 5). C_1 d_1 e_1 are minute and smooth others are barbed. Setae are barbed only on one side but the basal portion has a membranous frill instead of being smooth or barbed (Fig. 6). Figure 7 shows the setal orientation of the infracapitulum and coxisterna. Only setae *a* on the infracapitulum are smooth. All paraxial setae on the coxisterna are minute and smooth and the antiaxial seta on coxisterna—I is minute and smooth which may be clearly seen in Fig. 8 which also depicts the chaetotaxy of the first leg with sharply bent claw.

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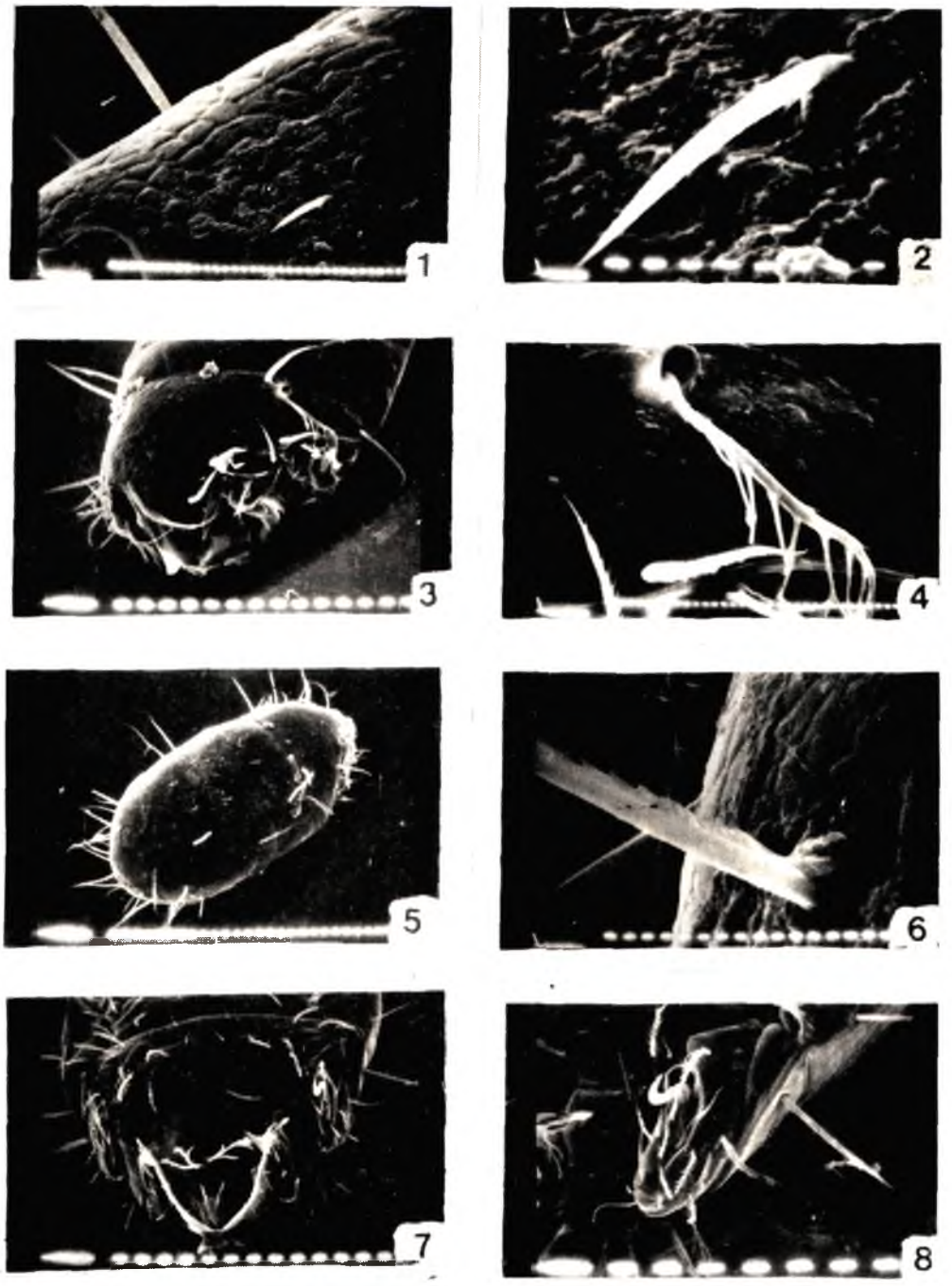

LEGEND TO FIGURES

1—Microsculpture on the dorsolateral side of the notogaster; 2—Same enlarged showing seta d_1; 3—Anterolateral aspect of the prodorsum; 4—Enlarged view of pseudostigmatic organ, seta *ex1* and prodorsal ridge; 5—Dorsum of *A. longisetosus*; 6—Basal portion of the seta h_1; 7—Ventral view showing infracapitular and coxisternal setae; 8—Tarsal chaetotaxy of leg I.

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A NEW SPECIES OF *ERICOLOPHIUM* TAO (HOMOPTERA : APHIDIDAE) FROM INDIA

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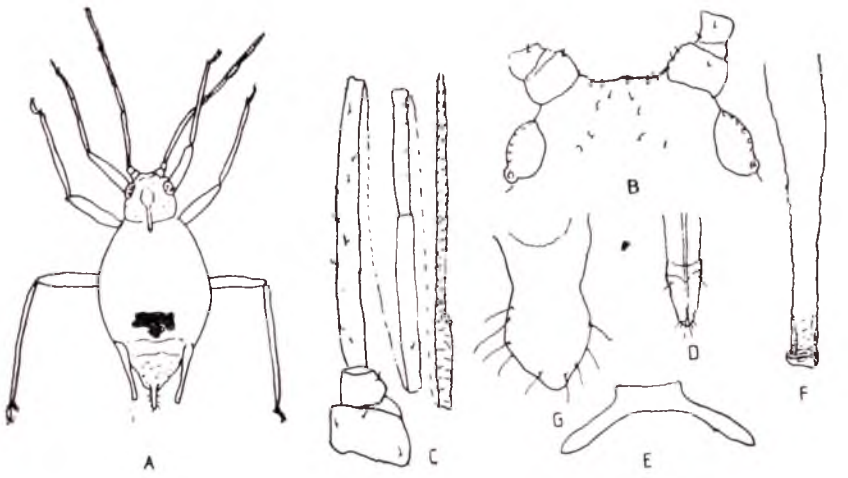
Hitherto monotypic genus *Ericolophium* Tao, 1963 is rhported through the description of a new species, *E. sikkimensis* from India from a host belonging to Ericaceae.

(Key words: new species. aphid)

Ericolophium sikkimensis, n. sp.

Apterous viviparous female : Head (Fig. B) with dorsum somewhat scabrous, venter smooth, lateral frontal tubercles well developed and diverging with inner margins scabrous, median frontal prominence conspicuous; dorsal cephalic hairs long with subacute apices. Antenae (Fig. C) 6-segmented, shorter than body; without secondary rhinaria; segment III indistinctly imbricated, rest of flagellum gradually distinctly imbricated apicad; processus terminalis 0.38 — 0.40 × base of segment VI; flagellar hairs short, with blunt to subacute apices. Rostrum reaching up to midcoxae; ultimate rostral segment (Fig. D) stout with blunt apex, shorter to little longer than 2nd segment of hind tarsi and bearing 2 secondary hairs. Midthoracic furca (Fig. E) with a broad base. Abdominal dorsum smooth, with a variably developed median pigmented patch extending over tergites 3–5 (Fig. A); dorsal hairs on tergites 1–6 short with acute apices, those on tergites 7 and 8 longer, with subacute to acute apices, tergite 8 with 4–5 hairs, the longest one about 1.88 — 2.37 × basal diameter of antennal segment III. Siphunculi (Fig. F) cylindrical tapering towards apex, pale brown with apical $\frac{1}{3}$rd distinctly imbricated, rest sparsely so, with a few transversely drawn out cells near apex which is with a flange; about 0.23 — 0.26 × body and 2.09 — 2.35 × elongated cauda (Fig. G) with slight constriction near the base and bearing 5 – 9 hairs. Legs very pale to pale brown; femora smooth except somewhat scabrous apical $\frac{1}{3}$rd portion; tibiae imbricated but distinctly so on apical half; both tarsal segments brown, second tarsal segments strongly spinulose ventrally; but only normally imbricated on the other surface; first tarsal chaetotaxy 3, 3, 3. Late instar nymphs with a few spinules towards apex of hind tibiae.

Comments: The new species is the second member of the genus *Ericolophium* TAO, 1963, distributed in Japan and Taiwan by its other member *itoe* (TAKAHASHI, 1925). *E. sikkimensis* differs from *E. itoe* in having a distinct dorsal patch on the abdomen and in the ultimate rostral segment which is short and blunt and bearing few setae.



Ericolophium sikkimensis, n. sp. apterous viviparous female: A. whole body; B. dorsum of head; C. antenna; D. ultimate rostral segment; E. midthoracic furca; F. siphunculus; G. cauda.

Dr. M. Miyazaki, Japan and Dr. V. F. Eastop, British Museum, London noticed the similar variations in the new species when requested to compare with other materials in their collections. With the present finding the genus has now its distribution extended to India in the Southeast Asia. While Miyazaki (1971) considered *Ericolophium* a distinct biological group of *Elatobium* Mordvilko, 1914 in a broader sense, Eastop and Lamber (1976) preferred to designate the two taxa as distinct genera.

Measurments of the holotype in mm: Length of body 2.59, width 1.12; antenna 2.02, segments III : IV : V : VI 0.56 : 0.33 : 0.28 (0.18 + 0.48); u. r. s. 0.08; h. t. 2 0.13; siphunculus 0.65; Cauda 0.27.

Collection data : **Holotype** : Aptera vivipara from an unidentified plant of Ericaceae, Lachung (*c* 3000 m), Sikkim, 24.xi.1983; **Paratype**: 6 apterae viviparae, same collection data, 2 in the collection of Dr. V. F. Eastop, British Museum, London and one in the collection of Dr. M. Miyazaki, National Institute of Agro-Environmental Sciences, Ibaraki, Japan respectively Coll: S. K. Mohapatra.

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BRIEF COMMUNICATION

ROLE OF CERTAIN FEMALE INTERNAL REPRODUTIVE ORGANS FOR RECOGNIZING VARIOUS TEXT OF THE FAMILY GEOMETRIDAE (LEPIDOPTERA : DITRYSIA)

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The female reproductive organs of eighteen species referable to three subfamilies i. e., Geometrinae, Boarmiinae and Scopulinae of family Geometridae have been studied. Besides the use of these organs for the separation of species it has been inferred that the *ductus seminalis* can be considered a higher taxonomic character as it always originates from the lateral side of the ductus bursae in all the geometrid moths studied here.

(Keywords: female internal reproductive organs, taxa, Geometridae)

During the course of present investigations, five to seven individuals for each sex of eighteen species of three subfamilies of the family Geometridae have been dissected to study the structure and significance of the internal female reproductive organs. Such studies in this group of moth in particular and the order Lepidoptera in general are extremely scanty, as far as the Indian species are concerned. In fact, so far, there is no report as to whether some parts of the female reproductive system can be incorporated for the characterization / diagnosis of various genera as well as the family itself, though the interspecific discrimination is possible through the use of various reproductive organs.

The internal female reproductive organs in the family Geometridae like other ditrysian Lepidoptera mainly comprises of a pair of ovaries constituting four ovarioles; a pair of lateral oviducts; common oviduct; bursa copulatrix i.e. corpus bursae, ductus bursae and ostium bursae; spermathecal complex i. e., spermathecal gland, spermatheca and spermathecal duct; a pair of accessory glands, lateral accessory reservoir and accessory duct. These parts have been shown in Fig. 1. in *Tephrina disputaria* Guenée which relates to the sub-family Boarmiinae, a representative of family Geometridae.

The variations occurring in eighteen different geometrid species relating to their reproductive organs are tabulated in Table 1 and these can be used for their distinction.

In the genus *Tephrina* Duponchel, the signum is always star shaped and the accessory gland becomes narrow towards its distal end and in the genus *Hyperythra* Guenée the spermatheca is observed to be of bilobed nature. These characters can be incorporated in the diagnosis of the respective genus, subject to the study of their type-species.

TABLE 1. Showing average length of internal female reproductive organs (mm) in family geometridae.

	OVR	LO	CO	UT	SG	SPD	AG	LRAG	AD	CB	DB	SD
Subfamily geometrinae												
Thalassodes falsaria Prout	9.3	0.3	1.2	1.2	3.3	0.95	2.6	1.1	0.8	1.5	1.9	1.4
Comibaena cassidora (Guenée)	10.3	0.4	0.7	0.45	0.25	1.3	11.6	1.6	0.35	1.2	0.35	0.8
Chlorissa punctifimbria (Warren)	5.8	0.9	1.0	0.65	5.2	1.2	9.3	2.3	0.7	1.2	1.7	2.4
Subfamily Boarmiinae												
Semiothisa frugaliata Guenée	18.4	2.1	0.8	1.1	3.4	1.2	4.1	0.9	0.5	2.4	1.3	2.4
Semiothisa pervolgata Walker	8.4	2.4	1.1	0.61	5.1	1.8	4.6	0.9	1.3	0.8	1.3	3.2
Semiothisa sufflata Guenée	18.2	2.7	1.6	0.9	2.4	1.1	6.6	1.4	0.5	1.6	1.5	3.2
Hyperythra lutea Gramer	8.1	0.3	0.6	0.8	5.7	1.1	4.3	2.1	0.4	5.3	1.3	0.4
Hyperythra swinhoei Butler	13.5	1.2	1.5	1.2	5.4	1.3	10.2	1.4	0.8	6.5	1.3	0.9
Alcis variegata Moore	18.8	2.2	1.6	1.1	3.1	1.1	7.4	0.85	0.3	1.3	6.1	3.1
Ascotis imparta Walker	13.4	0.6	4.1	4.8	6.2	1.2	15.4	1.2	0.6	2.8	4.8	1.1
Tephrina disputaria Guenée	16.5	1.7	1.4	1.1	3.2	0.85	8.4	0.91	0.45	1.2	1.6	2.6
Tephrina catalaunaria Guenée	6.2	0.9	0.7	0.7	3.1	1.4	6.1	0.8	0.6	1.8	0.9	4.1
Subfamily Scopulinae												
Scopula emissaria (Walker)	15.8	0.25	0.4	0.6	4.3	1.1	7.4	0.9	0.5	0.95	1.1	0.4
Scopula nictata (Guenée)	14.5	0.5	0.75	0.85	2.3	1.1	4.3	0.6	0.8	2.1	0.4	1.4
Scopula remotata (Guenée)	4.2	0.6	0.85	2.1	1.2	3.6	0.95	0.3	0.6	1.6	0.85	0.7
Traminda mundissima varigata Prout	10.2	0.4	1.4	0.6	12.8	2.3	2.3	2.1	1.8	2.2	1.8	2.8
Zygophyxia relictata (Walker)	9.2	0.7	1.3	0.9	5.3	1.3	3.4	0.9	0.5	3.1	1.2	2.2
Ptochophyle togata Fabricius	6.2	0.4	0.9	0.8	4.2	1.2	2.1	0.2	0.7	1.6	1.8	1.6

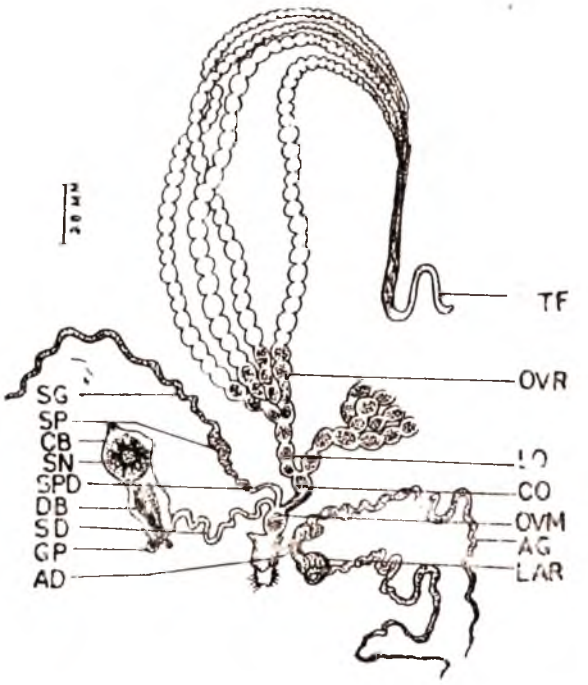

Fig. 1. Female internal reproductive organs of the *Tephrina disputaria* Guenée.

ABBREVIATIONS USED

AD, Accessory duct; AG, Accessory gland; CB, Corpus bursae; CO, Common oviduct; DB, Ductus bursae; GP, Genital plate; LAR, Lateral accessory reservoir; LO, Lateral oviduct; OVM, Ovum; OVR, Ovariole; SD, Seminal duct; SG, Spermathecal gland; SN, Signum; SP, Spermatheca; SPD, Spermathecal duct; TF, Terminal filament.

One of outstanding evaluations of the present studies is that in all the species pertaining to the subfamilies Geometrinae, Scopuline and Boaramiinae, studied here, the ductus seminalis always originates from the lateral side of the ductus bursae. This goes in accordance to the hint given by KLOTS (1970) that the origin of this duct can be of great taxonomic significance. The present findings, thus, accordingly lead to the inference that the origin of ductus seminalis can be used as a higher taxonomic character for the characterization of the family Geometridae, for which the study of additional species from other subfamilies may throw more light.

Acknowledgement: The authors wish to express their gratitude to Prof. H. R. PAJNI and Dr. V. K. WALIA of the department of Zoology, Punjab University, Chandigarh for their help in confirming the identity of the species and offering constructive criticism.

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BRIEF COMMUNICATION

OCCURRENCE OF CYTOPLASMIC POLYHEDROSIS VIRUS IN *SPILOSOMA OBLIQUA* WALKER

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(Received 28 June 1985)

Incidence of cytoplasmic polyhedrosis virus either alone and in combination with *Nosema* sp. spores has been reported along with symptomatology and electron micrsscopic observation of pathogens.

(Key words: cytoplasmic virus, *Nosema* sp. *Spilosoma obliqua)*

Spilosoma (Diacrisia) obliqua commonly known as Bihar hairly caterpillar, is an important polyphagous pest causing heavy foliar damage to various crops. During the course of field survey on field beans, *Lab-lab purpureus* (Linn.) Sweet, a cytoplasmic polyhedrosis virus was isolated from a few dead caterpillars of *S. obliqua*. The diseased caterpillars were small and on tissue examination revealed numerous inclusion bodies. Though, a fungal (THONTADARYA *et al.*, 1973), a nuclear polyhedrosis virus (JACOB & THOMAS, 1972) and a protozoan pathogen (NARAYANAN, 1985 a) have been reported earlier, occurrence of cytoplasmic polyhedrosis virus (CPV) in *S. obliqua*, appears to be the first report in India. Further, the present communication deals with some observations on the symptomatology, pathogenicity and electron microscopic observations of inclusion bodies alone and in combination with mixed infection of protozoan pathogen in *S obliqua* larvae.

Contribution No. 82/85 of the Indian Institute of Horticultural Research, Bangalore 560 089.

Polyhedral inclusion bodies (PIB) of CPV were purified from the diseased larvae of *S. obliqua* by differential centrifugation. A test was conducted to determine its pathogenicity against the larvae of *S. obliqua*, which were maintained on artificial diet (NARAYANAN 1985 b). Suspension of PIB of CPV was applied on the surface of the diet and 8 days old larvae were allowed to feed. Diagnosis of the diseased and dead larvae was done by microscopic examination of the tissue smear under the phase contrast microscope for the presence of PIBs as well as by the negative Giemsa staining technique.

The symptoms of the CPV infected *S. obliqua* generally resembled those that described for other CPV infected lepidopterous larvae (SMITH, 1963). Living diseased larvae of *S. obliqua* showed typical sluggishness in their movement and they lagged behind in their development and they are also less responsive to tactile stimuli. The infected larvae remain living as small and shrunken even after the control larvae had completed pupation and emerged as adults.

Fig. 1. Healthy (H) and diseased (D) gut of *S. obliqua*.

Fig 2. Electron micrograph Polyhedral inclusion bodies (PIB) of cytoplasmic polyhedrosis virus (CPV) of *Spilosoma obliqua* along with *Nosema* sp. spore PIB = Polyhedral Inclusion Bodies; N = *Nosema* sp. spore.

Further, in contrast to healthy larvae of *S obliqua*, the CPV infected *S. obliqua* showed clear-cut whitening of the integument on the ventral side, due to accumulation of large number of inclusion bodies. The incubation period ranged from 12 to 30 days. Upon dissection of a diseased larva, instead of translucent and pale green colour of the normal midgut, the gut was opaque and light white thinner in size (Fig. 1). On examination of the midgut tissue in wet mounts, with the use of phase contract microscope, revealed numerous round and hexagonal shaped inclusion bodies emanated from the ruptured cells. Samples from the insects for which positive diagnosis has been made with phase-microscopy were further confirmed by the negatively stained PIB with Giemsa as well as by electron microscopic observation.

To determine the size of the PIBs, one hundred PIBs were measured at random under a phase-contrast microscope and the readings were taken at 400 × magnification and it was found that the size of the PIBs was varied ranging from 0.2 to to 2.5 μ with an average of 1.4 μ in diameter.

In the course of our observation, it has also been found, that some of the *S. obliqua* that died after feeding CPV contaminated diet, was found to contain spores of *Nosema* sp. along with PIBs of CPV (Fig. 2). Though, the occurrene of *Nosema* sp. has been reported earlier (NARAYANAN, 1985a), the occurrence of *Nosema* sp. along with CPV appears to be the first report. Similar such mixed infection of CPV with protozoan has been reported in the case of *Pseudaletia unipuncta* (TANADA, 1962). The presence of of protozoan spores in the present study may be possible by the activation of latent protozoa already present in *S. obliqua* to manifest into a frank infection due to the stress caused by the inoculation of CPV. Similar activation and mixed infection of CPV along with protozoans have already been reported in *Heliothis zea* (LIPA, 1968) and in *Spodoptera exempta* (PILLEY, 1976).

Acknowledgement. The author is grateful to to Dr. S. J. SINGH for his help in taking Electron microspic picture and to Mr. D. L. SHETTI for his technical help and to Dr. K.L. CHADHA, Director of the Institute, for the facilities provided.

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REPRODUCTIVE BIOLOGY OF THE STORED PRODUCT PEST *ARAECERUS FASCICULATUS* (COLEOPTERA : ANTHERIBIDAE)

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One year old market samples of dry cassava chips collected during monsoon season, before the arrival of new stock showed 44.30±16.66 insects/150g. Female *A. fasciculatus* reached maturity within 4—7 days and males within 3 days of emergence. Mature adults showed characteristic mating behaviour. Vitellogenic oocyte differentiation could be noticed from the third day of adult emergence.

(Key words: Araecerus fasciculatus, mating behaviour, fecundity)

Araecerus fasciculatus is a major pest of stored cassava chips, causing considerable damage (REGHUNATH & NAIR, 1970). Infestations become severe within 2 to 3 months after storage. Adult beetles make shallow furrows on the chips and deposit their eggs and the developmental stages are completed within the chips. The present study was undertaken to gather information on the mating behaviour, ovarian development, fecundity and also the population of this insect under natural conditions.

Cassava chips were collectd periodically from two retail shops (3kg at a time) and ten 150g samples were kept in well protected containers for a period of 45 days, the normal developmental period of the insect. Emerged adults were collected daily. The average number of insects thus obtained was taken as an index of the population. On an average, 44.30±16.66 insects were obtained from the 150 g samples of cassava chips. Such high population was found only in one year old stocks before arrival of fresh stock during the monsoon months. In December to February samples constituting fresh arrivals, there was no sign of infestation, while March samples showed beginning of insect atttack.

Newly emerged adults were sexed and 1 to 10 day old ones were used for observing their mating behaviour. On introduction of a 4 day male into the mating arena where a mature female (4 days and above) was present, he moved around for a while; on locating the female, he gradually followed her. Soon the movements became brisker and the male tried to stop the female by holding her. In the beginning, the female hesistated to mate and often tried to escape. Non-receptive females prevented mating by pressing her abdominal tip to the substratum. In the case of receptive female, the pre-mating behaviour extended from 3 to 20 minutes. During this period, the male held the female by his fore limbs and bent his body to bring the abdominal tip in close approximation with that of the female. Immediately after this, the copulatory tube was extended. The female moved its genitalia

so as to allow the male to introduce the copulatory organ. Soon after this, the male released his hold on the partner. Male was found to rub his fore limbs on the appendages of the female and climbed over the female. During mating, the male held his antenna on either side of the body. The duration of mating ranged from 4 to 30 minutes. Usually mating was completed in two stages. At the end of the first stage, the male withdrew the copulatory organ, remained on the female and exhibited post mating behaviour such as rubbing of mouth parts, legs and antennae on the female. Then the second stage of mating followed. In the case of insects which took longer time (25 to 30 minutes) for the first stage, no post mating behaviour or second stage of mating was noticed. In may females a second mating could be recorded within 3 to 4 days after the first one as in *Trogoderma granarium* (KARNANAR, 1972). A single female often attracted more than one male at a time, but only one male succeeded in mating. During this process, the intruding males were kicked away by the successful one.

Sexual maturity in the female was studied by using insects of known age (1 to 10 days). The mating behaviour of a batch of females of different age was observed. In addition to this, several females were dissected and the developmental stages of their ovaries ascertained; 1 to 3 day old females did not mate. The first mating took place between the 4th and 7th day after emergence in the case of females and 3 days in the case of males. In newly emerged females, the ovarian follicles were long transparent tube united to form a bundle. No vitellogenic oocytes could be noticed at this stage. In the mature female, the reproductive system consists of a pair of ovaries, each with five follicles containing two to three differentiated vitellogenic oocytes.

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IDENTIFICATION OF SOME LEAF ROLLERS BELONGING TO THE GENERA *BRADINA, MARASMIA* AND *CNAPHALOCROCIS* (LEPIDOPTERA, PYRAUSTIDAE)

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(Received 14 May 1985)

Insects belonging to the genera *Bradina, Cnaphalocrocis* and *Marasmia* (Lepidoptera : Pyraustidae) are generally pests of various graminaceous crops. The general appearance and shared behavioural habits of the larvae and adults render recognition of the various species difficult. In order to facilitate correct identification of species found in Kerala, the authors have devised an identification key using morphological characters of their external genitalia.

(Key words: leaf rollers, *Bradina, Marasmia, Cnaphalocrocis)*

INTRODUCTION

The Pyraustid genera, *Bradina*, *Marasmia* and *Cnaphalocrocis* were erected by Lederer in 1863. Species belonging to these genera have a wide distribution and occur in the Oriental, Australian and Ethiopian regions (Hampson, 1896). They are economically very important as pests of several graminaceous crops throughout the world. Thus, *Cnaphalocrocis medinalis* popularly known as the paddy leaf roller is a severe pest of that crop in several countries. *Marasmia trapezalis* and *M. venilialis* attack paddy as well as maize in India (Fletcher, 1919). Bradley (1981) reported *M. patnalis* as a pest of paddy in South East Asia. Recently, an instance of diarrhoea to cattle fed on fodder grass infested by caterpillars of *Bradina admixtalis* was noticed at Mannuthy (Kerala).

Field identification of these insects is rather difficult because of the shared characterestics of the larvae as well as the adults. The caterpillars are mostly greenish in colour and feed from within folded leaves, the margins of which are held together by silken threads. Usually a single larva is present in a fold; some times the same leaf may be folded at different points, each fold harbouring a larva. On finishing the green matter, the caterpillars move to fresh, unattacked leaves. Moths are generally light coloured and are closely alike in their general coloration and wing pattern. For the determination of species there is no standard key available except for the species descriptions given by Hampson (1896). Identification is difficult using these descriptions since the colour pattern might be lost while handling the moths. In the present study an attempt has been made to device an identification key based on the morphological characters of their external genitalia.

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MATERIALS AND METHODS

The insects studied here were field collected by sweeping with a hand net and by setting up light traps at different localities. Segregation of moths upto the generic level was done by using the key given by Hampson (1896). Tentative identification up to the species level was made by reference to the available literature as well as by comparison with named specimens in the collections of Forest Research Institute, Dehra Dun and Indian Agricultural Research Institute, New Delhi. The identity of these moths were subsequently got confirmed by referring to the Commonwealth Institute of Entomology, London. The wing venation and male genitalia of 6 specimens belonging to each species was studied. For the description of parts of the genitalia, the terminology given by Klots (1970) has been used.

RESULTS

Six species of pyraustid leaf-rollers viz., *Cnaphalocrocis medinalis*, *Marasmia venilialis*, *M. bilinealis*, *M. trapezalis* *M. trebiusalis* and *Bradina admixtalis* were found to attack graminaceous plants in Kerala (Mathew and Menon, 1984). All these species are characterised by the approximation or partial fusion of the hindwing veins Sc–R–1. In the genus *Bradina*, the forewing veins 8, 9 and 10 are stalked towards the tip, while in *Cnaphalocrocis* and *Marasmia*, only the veins 8 and 9 are stalked. In *Cnaphalocrocis*, the venation is further characterised by the possession of stalked forewing veins 10 and 11 and anastomosing of the hind wing vein 7 with 8 to almost the apex and in *Marasmia*, the forewing vein 10 is very closely approximated to veins 8 and 9 instead of being stalked with vein 11. The genitalial morphology of the species studied here, is discussed below:

1. Bradina admixtalis Wlk. (Figs. 6, 8)

Male: Uncus constricted in the middle, with the posterior half more swollen, apex expanded and lobe-like with tufts of hairs on the dorsal and ventral aspects. Tegumen flat; vinculum rhomboidal. Valvae long, base narrow, costa bulged out in the middle. Along the costal margin runs a sclerotized patch which at 1/3rd distance from base bears an inwardly directed hook. Cucullus bears a long tuft of hairs which extends upto the middle of the valvae. Sacculus with a sclerotized bar which runs for the whole length of the ventral margin of the costa. Harpe with a long spine-like process which extends beyond the costal spine.

Phallus with the distal portion swollen with a notched tip. Proximal portion long and slender.

Female: Bursa very long and tubular, basally produced into a slight caecum. An oval receptaculum seminis opens into the bursa, a little above its base. Ductus short with rows of spinules at the posterior end. Anterior apophyses about double the size of the posterior. Ovipositor short with narrow ovipositor lobes.

2. Cnaphalocrocis medinalis Guen. (Figs. 5, 7)

Male: Uncus short and obtuse with two oblong-oval processes covered with transverse rows of short hairs. Tegumen short, fringed with long hairs. Vinculum with the saccus large and V-shaped. Valvae short and ovate. Costa with a broad sclerotized patch and fringed with long hairs in tuft. Sclerotization of the sacculus narrow.

Phallus short, proximal end conical and distal end flat. A long sclerotized patch inside.

Female: Bursa elongate oval. Ductus with the cephalic part broad and distal part narrow. Signum composed of a

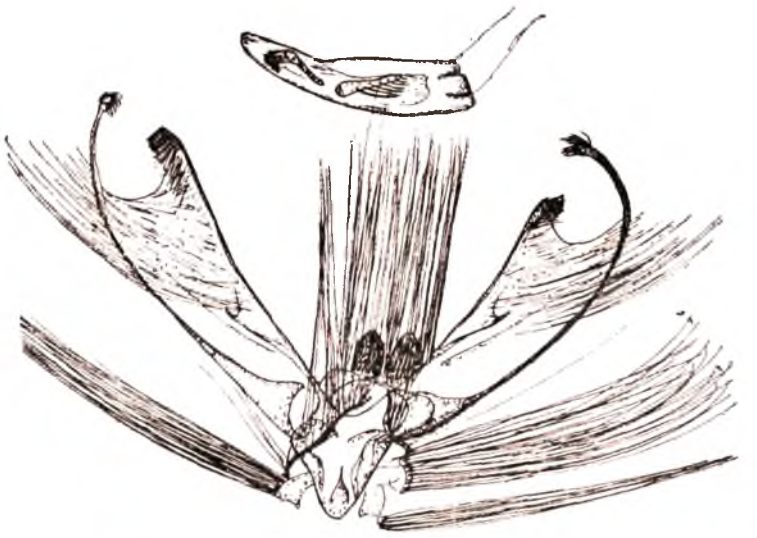

Fig. 1. Male genitalia of *Marasmia venilialis*.

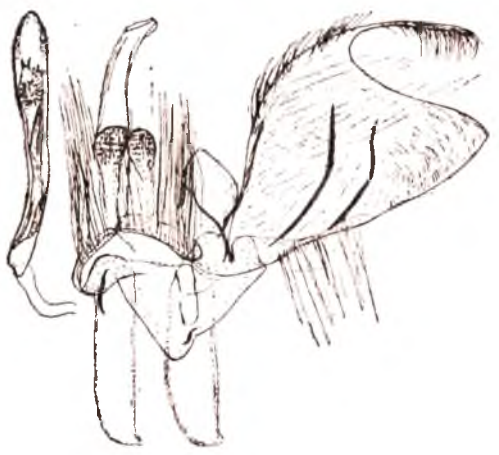

Fig. 2 Male genitalia of *M. trebiusalis*.

round process with scobinations. Apophyses of the same size. Ovipositor short with broad, swollen ovipositor lobes.

3. M. trebiusalis Wlk. (Figs 2, 9)

Male: Uncus short with two oval bodies covered with transverse rows of short spines. Arms of tegumen bearing a fringe of long hairs covering the uncus. In the vinculum, saccus massive and V-shaped. Valvae short and broad apically; postero-dorsal part produced into a long, slender process covered with hairs at the tip. The sclerotized patch on the sacculus broad at the base and fringed with long hairs. Clasper composed of two stout, long spines set longitudinally.

Phallus long and slender, dilated at the distal end. Cornuti composed of a sclerotized process bearing short stout spines at its tip and another rosette-shaped structure in the swollen part.

Female: Bursa globular. Ductus short, dilated and constricted in the middle and swollen at the posterior end. Anterior apophyses longer than the posterior, which are feeble. Ovipositor short and narrow with short ovipositor lobes.

4. M. trapezalis Guen. (Fig. 3)

Male: Uncus short and flat with two elongate, oval bodies covered with

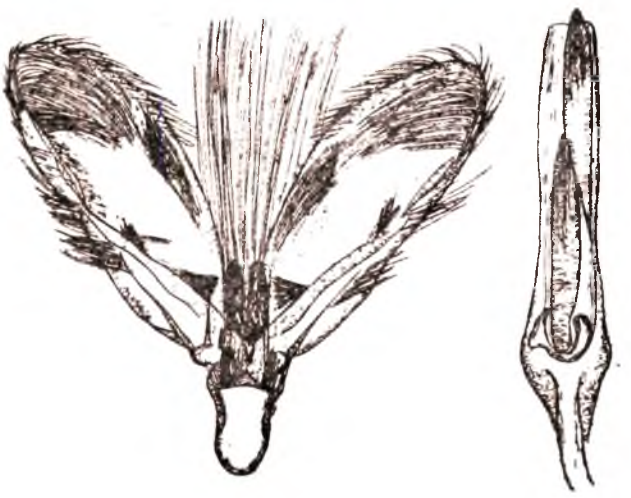

Fig. 3. Male genitalia of *M. trapezalis.*

Fig. 4. Male genitalia of *M. bilinealis*

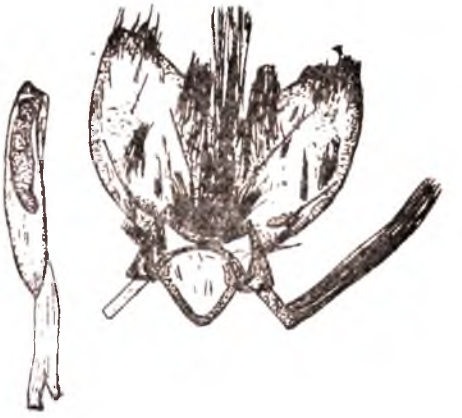

Fig. 5. Male genitalia of *Cnaphalocrocis medinalis.*

short stiff hairs. In the vinculum, saccus very long and ligulate. Valvae long and ovate covered with long hairs in patches. A median patch of short stiff hairs basally. Sacculus with a broad sclerotized patch bearing a stout spine at the base.

Phallus long and stout, swollen at the proximal end. Two rod-like sclerotized patches and a hook-like curved patch at the proximal end.

5. Marasmia venilialis Guen. (Fig. 1)

Male: Uncus short bearing two oval bodies covered with rows of short hairs. Tegumen short. Saccus large, V-shaped. Valvae elongate, apically depressed, the dorsal and ventral margins being produced

Fig. 6. Male genitalia of *Bradina admixtalis*.

Fig. 7. Female genitalia of *Cnaphalocrocis*.

Fig. 8. Female genitalia of *Bradina admixtalis*.

Fig. 9. Female genitalia of *Marasmia trebiusalis*.

Fig. 10. Fe male genitalia of *M. bilinealis*.

into slender processes, of which the ventral one being the longest. Costal sclerotization bears a short spine. The sclerotized patch on the sacculus broad at the base and runs as a narrow patch along the margin, extending beyond the apex of the valva.

Phallus short, stout. Cornuti composed of a sclerotized process bearing a row of long spines and another bearing spinules.

6. M. bilinealis Hmpsn. (Figs. 4, 10)

Male: Uncus short with two oval bodies covered with rows of short hairs. Saccus V-shaped. Valvae elongate, costa with a narrow sclerotized patch; sacculus bearing a stout spine-like process. Cucullus with rows of long hairs.

Phallus long and slender with a curved process forming the cornuti.

Female: Bursa elongate, basally constricted into a narrow handle-like portion. Signum composed of two round structures borne by a stalk. Ductus very short and narrow. Anterior apophyses stout; posterior ones feeble. Ovipositor short with narrow ovipositor lobes.

DISCUSSION

Male genitalia: Excepting *Bradina admixtalis*, all the species were characterised by the possession of a short uncus with two oval structures attached to it. The valvae were generally elongate, although apically depressed in *M. venilialis* and *M. trebiusalis*. The saccus was conical and V-shaped in most species excepting *M. trapezalis* and *B. admixtalis*, in which it was broadly U-shaped. A well developed phallus was present in all the species. The characteristics of the uncus, valvae and phallus are of taxonomic significance and very useful in species identification.

Female genitalia: Female genitalia of only 4 species, viz., *C. medinalis*, *M. bilinealis*, *M. trebiusalis* and *B. admixtalis* could be studied due to unavailability of female moths of the other species in the collection. In all the species examined, the bursa copulatrix was prominent and well developed. The ductus bursae was comparatively shorter and narrower except in *B. admixtalis* in which it was long and tubular. The features of bursae and ductus are of taxonomic significance.

Based on the present studies, the following key has been deviced for the identification of moths belonging to these genera:

KEY FOR THE SEPARATION OF GENERA

1. Forewing with veins 8 and 9 stalked towards the tip 2
— Forewing with veins 8, 9 and 10 stalked towards the tip..... *Bradina*
2. Forewing with veins 10 and 11 stalked ..... *Cnaphalocrocis*
— Forewing with veins 10 free and very closely approximated to veins 8 and 9 which are stalked..... *Marasmia*

KEY FOR THE SEPARATION OF SPECIES

1. Uncus low with two lobe-like processes. Ductus bursae short..... 2
— Uncus long and slender without such processes. Ductus bursae long and tabular ..... *Bradina admixtalis*
2. Valva with the apex truncate..... 3
— Apical end of valva not truncate..... 4
3. Valva apically with two slender lobe-like processes arising from the margins..... *Marasmina venilialis*
— Valva apically with a single lobe-like process, arising from the margin..... *M. trebiusalis*
4. Saccus V-shaped..... 5
— Saccus U-shaped. Phallus with two spine-like processes..... *M. trapezalis*
5. Valva with a median costal spine. Saccus pointed. Phallus with a curved process forming the cornuti..... *M. bilinealis*
— Valva without a median spine. Cornuti of phallus not curved... *Cnaphalocrocis medinalis*

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OBSERVATIONS ON THE BIONOMICS AND EPIDEMIOLOGICAL SIGNIFICANCE OF *ANOPHELES (CELLIA) PALLIDUS* THEOBALD, 1901 (DIPTERA : CULICIDAE) IN BASTAR DISTRICT, MADHYA PRADESH

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Studies on the anopheline fauna of Bastar District, Madhya Pradesh revealed distribution of *Anopheles pallidus* in 24 villages scattered in seven physiographical divisions with elevation range between 48.5 and 1275.5 m. The species seemed to rest outdoors in forest terrain while indoors in plain areas. Length and peak feeding activities of the female varied in different seasons. The density and seasonal prevalence of this mosquito increased in the rainy season. In the North-Eastern plateau with hot moist climate, this *Anopheles* appeared to be more numerous. Females were not captured biting human baits although 3.7 per cent anthropophilic index was noted in samples from cattlesheds. None of the females dissected was infected with malaria parasites.

(Key words: bionomics. epidemiology, *Anopheles*, Bastar District, Madhya Pradesh, India)

INTRODUCTION

Anopheles pallidus is widely distributed in the compact area of the Oriental Region comprising India, Nepal, Ceylon, Bangla Desh, Thailand and Indonesia. It has not so far been reported from other areas of the world. PURI (1955) has summarised its distribution in India.

In Bastar District present studies were undertaken to seek information on the anopheline fauna and its relation to malaria. PRAKASH & HUSAINY (1974) discussed distribution pattern and HUSAINY (1978 a, b) reported the bionomics of *Anopheles aconitus* and *Anopheles varuna*. In this paper observations on *Anopheles pallidus* have been described and discussed.

AREA AND CLIMATE

The Bastar District lies roughly in the central part of India and extends from 17° 46′ N to 20° 34′ N latitude and from 80° 15′ E to 82° 1′ E longitude. It has an area of 39,086 sq km containing 3154 villages and three towns which fall into five main physiographical divisions (Fig. 1). Almost 70 percent (22,169 sq km) of the area is covered with forests. The altitude ranges from 48.5 m (village Konta) to about 1275 m (village Bailadila). This district shares a monsoon type of climate with the general Indian landmass, although diversity of its terrain does not encourage a uniform climate. The period from March to mid-June embraces dry early summer while from mid-June to October it is wet late summer. The winter season is from November to February while the period from June to October covers general rainy season. There are three distinct mean temperature divisions viz: 22° to 24°C, 24 to 27°C and

27 to 29°C. There may be two annual rainfall divisions e.g. 152 to 178 cm and 127 to 152 cm. With three temperature and two rainfall divisions, the district is divisible into five climatic patterns. The types of climate met with in the respective physiographical divisions are indicated in Fig. 1. The villages consist of several hamlets called "paras" each with a few hutments situated at some distance from one another. The area is sparsely populated. Every family residing in the village generally keeps such domestic animals as cow, goat, pig, dog and poultry. Most of these are accommodated in rickety cattle sheds.

MATERIALS AND METHODS

To detect resting anophelines, day and night time general and routine collections were made inside human dwellings and cattle sheds of selected villages. Collections were also made by the pyrethrum spray technique inside human dwellings. Outdoor collections were made in early morning hours in the area between nearest potential larval habitat and human dwellings. A pit shelter was made in village of Bispur under a tree in a rice field located in between a pond and a house. Its size was 2m×1m×2m deep. Two pits each of size of $\frac{1}{2}$ m × $\frac{1}{2}$ m × $\frac{1}{2}$ m deep were excavated on each of the wall of pit and a ladder was placed on one side of the pit. Finally a roof of matting was laid on this pit leaving a gap at the side of the ladder, for entrance. Collections were made in this pit for 15 minutes every morning. In order to determine feeding times and seasonal prevalence, all night collections were made between 1800 and 0600 hr at intervals of two hours for half an hour each time. Adjustment of first collection hours in relation to the time of sunset at different times of the year was made in the study; however, the remaining collections of the night were made at fixed times all round the year.

Man-biting rates were determined by placing a man as a bait and another collecting mosquitoes actually feeding this bait since landing rates do not always ndicate biting. In all campaigns, mosquitoes were collectd by an aspirator and torch light and were identified at the end of collection on the spot in either sun or bright petromax light and their species, abdominal conditions and time and site of captures were noted. The source of blood meal taken by females was determined by precipitin tests. Females were dissected to determine parity status and sporozoite infection.

OBSERVATIONS

Between August 1969 and January 1975 a total of 21,716 specimens of 19 species of *Anopheles* was collected in 1206 man hours. This collection had 827 specimens (2 males and 825 females) of *Anopheles pallidus* which were found in

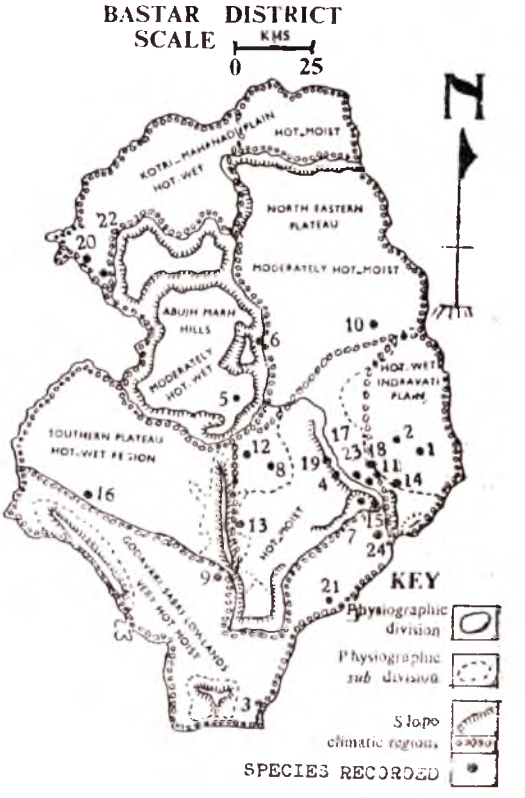

Fig. 1. Map of Bastar district showing climatic physiographic divisions and distribution of *A. pallidus*. For locality serials please refer text.

24 villages out of 105 surveyed (Fig. 1). The number of specimens taken from each village is given within the brackets while the name of each village is preceded by a numeral which marks its location on the map.

Specimens collected

1. Adhawal (9); 2. Aghanpur (150); 3. Asirguda (16); 4. Bispur (10); 5. Burdum (3); 6. Chote Dongar (4); 7. Durbha (343); 8. Gumda (3); 9. Jagargunda (1); 10. Jare Bendri (1); 11. Kamanar (112); 12. Karlee (6); 13. Kirandul (2); 14. Kotamsar (38); 15. Kukalgur (45); 16. Madded (2); 17. Mamadpal (38); 18. Mangnar (60); 19. Paknar (1) 20. Project village 22 (28); 21. Sukma (29); 22. Tahakwada (19); 23. Tirathgarh (6); 24. Tongpal (17).

Distribution

This species was recorded from the Kotri-Mahanadi plains; North-Eastern Plateau, Abujh Marh Hills; Indravati Plains; Dantewara Plains; Southern Plateau, and Godavari-Sabri Lowlands. This mosquito was taken in all the climatic belts of the district. The elevation of the distribution ranged from 48.5 to 1275.5 m.

Diurnal resting places

From Table 1 it may be seen that in cattle sheds 782 specimens were encountered in the night as against only 2 females collected in the day time. In houses 15 fully gravid females were found in the day time while none was captured during the night. The common indoor resting sites of this *Anopheles* were the thatched roofs, wall surfaces and the hanging objects both in cattle sheds and the human dwellings. Out of doors two males and 19 females (six unfed, five fed and eight full gravid) were taken in bushes along the banks of the streams in two forest villages: P. V. 22 (Kotri Mahanadi Plains) and Karlee (Dantewara Plains) in November and April respectively. It seems that in such forest terrain this species also prefers to rest out of door during the day time.

Feeding times of female adults

From August 1969 to February 1974, 78 all night routine catches were made

TABLE 1. Composition of *Anopheles pallidus* captured at various sites in Bastar district, M. P.

No.	Habitats	Man-hours spent	Nos. collected male	Nos. collected female	per cent
1.	Cattlesheds				
	A. From 0500 to 1800 h	144	0	2	0.2
	B. From 1800 to 0500 h	702	0	789	96.7
2.	Houses				
	A. From 0500 to 1800 h	139	0	15	1.8
	B. From 1800 to 0500 h	117			
3.	Outdoors				
	From 0600 to 1800 h	104	2	19	1.3
	Total	1206	2	825	100.00

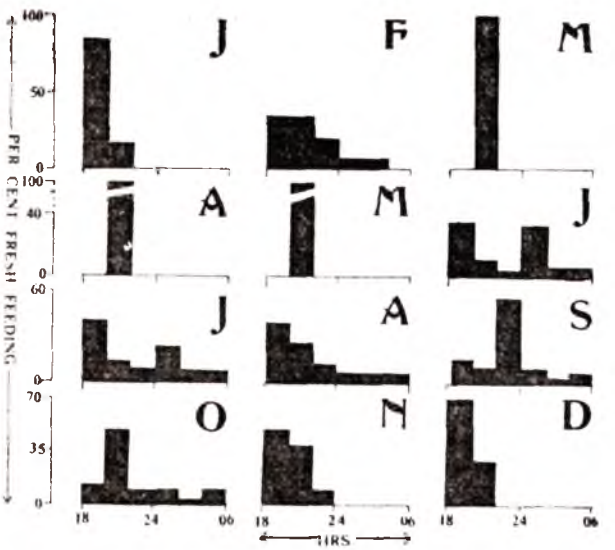

Fig. 2. Feeding times of *A. pallidus* female adults at village Darbha, Bastar district.

in forest village of Darbha to determine the biting times of the female adults. During these campaigns, 306 freshly fed females of *Anopheles pallidus* were found resting in the ricketty cattle sheds. The monthly biting cycles based on combined data at different hours are displayed in Fig. 2.

During the early rainy season (June–July) peak of the biting activity of *Anopheles pallidus* was noted just after sunset i.e., between 1800 and 1900 h after which the activity fell off and then rose to a second but less prominent peak between 2400 and 0030 h and declining thereafter. In August although the feeding ranged between 1830 and 0430 h, no distinct peak was discerned at any time which may be due to heavy rains causing disturbance in the influx of females. In September this mosquito was taken in increasing numbers after dark peaking between 2200 and 2230 h and diminishing through the night gradually. In October the feeding continued from sunset to sun rise with more feeding around 2000/2030 h till January. From November onwards the feeding periods gradually shortened and the peak of activity occurred just after sunset. During summer (March–May) when this *Anopheles* was least numerous feeding activities were noted around 2000/2030 h only.

Density buildup

In the cattlesheds of village of Darbha between October 1967 and September 1970, 36 regular all night catches (252 man hour) were made which yielded 2866 specimens of 18 anopheline species including 152 specimens of *Anopheles pallidus* (Table 2). It seems that with the onset of rains the density of this mosquito gradually increases reaching a peak in July and gradually declining through winter (February) becoming least numerous in summer.

Seasonal prevalence

In Table 2 monthly composition of

TABLE 2. Seasonal prevalence of *Anopheles pallidus* in Bastar district and at other places.

Month	Bastar district (1)		Numbers taken at					Nilgiris Dist. (7)	Madras
	during density buildup at Darbha Actuals	seasonal composition in other villages Actuals	Rupsa Kharagpur(2) Actuals	Puri, Orissa (3) Actuals	North Arcot South India (4) %	Udaipur Madhya Pradesh (5) Actuals	South Kanara Mysore (6) Actuals	East per manhour	West per manhour
January	9	30	—	20	12	—	—	0.1	—
February	22	10	6	20	15	—	—	—	—
March	1	12	2	10	5	—	—	—	—
April	1	13	3	10	1	—	—	—	—
May	1	7	0	11	0.5	—	—	—	—
June	13	38	0	15	1	—	—	—	—
July	46	197	43	3	1.5	75	—	—	—
August	7	165	90	5	1	181	—	—	—
September	15	67	61	12	2	245	—	—	—
October	20	47	70	13	22	216	—	—	—
November	10	63	53	37	25	242	1	—	—
December	7	26	36	41	15	132	—	—	—
Season of abundance		Rainy	Rainy	Winter	Winter	Winter	Rare species	Rare species	

(1) Present studies; (2) Ganguli (1947); (3) Panigrahi (1942); (4) Reuben (1971)
(5) Subramanian and Sengupta (1950); (6) Ramakrishnan *et al.* (1948); (7) Russell and Jacob (1942).

Anopheles pallidus in other villages is also displayed. It may be seen that this mosquito was a perennial species and in rainy season (June–August) alone 400 specimens forming 59 per cent were encountered while in summer it appeared to be least numerous. The seasonal composition confirms the density build up pattern of this mosquito.

Area of abundance

Majority of villages where this species was recorded as more numerous are located in the North-Eastern plateau with the hot-moist climate and an elevation range from 609 to 761 m. This area had from 24 to 27°C annual mean temperature and over 152 cm annual rain fall. In Table 3 are shown the captures of *Anopheles pallidus* in various climatic belts of the district. In the hot-moist climatic belt which is mostly a forest area 444 specimens (forming 53.7 per cent of total) were encountered. This belt receives less rainfall than the hot-wet area where 281 specimens (forming 33.9 per cent of total) were collected. The hot-moist region receives over 152 cm annual rainfall and has the mean temperature from 24 to 27°C. In Moderately hot-wet and very hot-moist climatic belts which are the coolest and hottest parts and get highest

TABLE 3. Composition *Anopheles pallidus* in various climatic belts of Bastar District.

No.	Climatic ragion	Nos collected	Per cent
1.	Moderately hot-moist region	5	0 6
2.	Moderately hot wet region	3	0.4
3.	Hot-wet region	281	33.9
4.	Hot-moist region	444	53.7
5.	Very hot-moist region	94	11.4
	Total	827	100.00

and lowest rainfall respectively, this *Anopheles* was found less numerous.

Man biting rate

This mosquito was not secured from human baits placed inside houses during a total of 80 man-hours spent in the determination of man-biting rate although 330 females (67 anopheline and 263 culicine) were taken in three villages in these campaigns.

Anthropophilic index

In precipitin tests out of 53 smears of females taken in cattleshed, only two were found as human blood thus forming an anthropophilic index (AI) of 3.7 per cent in the samples tested.

Dissections

In Table 4 are displayed the results of the dissections of *Anopheles pallidus* females collected from various sites of the study villages. It was seen that 31 unfed females were found nulliparous indicating their fresh arrivals from breeding places for feeding. Sacs were seen in the ovarioles of 17 females while retained eggs were encountered in 6 females. Females with one and two dilatations in the ovarioles numbered 85 and 24 respectively while 19 females had three or

TABLE 4. Physiological age of female *Anopheles pallidus* captured at various sites of Baster district.

No.	Site of collection	Abdominal condition	Nos. dissected	Conditions of the ovarioles							Numbers positive gut/ glands	Numbers infected with ecto parasites (mites)
				Nulliparous	Sacs	Retained eggs	Number of dilatation 1	2	3	4 or more		
1.	Cattlesheds	Unfed	59	31	4	—	21	2	1		00/00	6
		Fed	367	254	13	6	62	20	18		00/00	16
2.	Human dwellings	Fed	2	—	—	—	—	2	—		00/00	—
3.	Outdoors	Unfed	1	—	—	—	1	—	—		00/00	
		Fed	2	1	—	—	1	—	—		00/00	1
		Gravid*	2	—	—	—	—	—	—		00/00	—
		Total	433	286	17	6	85	24	19		—	23

* Ovarioles of gravid females not seen.

more dilatations. Mites were recovered from 23 (6 unfed, 17 fed) females. Infection of the sporozoites of any *Plasmodium* spp. was not seen on the gut nor in the salivary glands of any female dissected.

DISCUSSION

This mosquito was found in forest as well as plain areas and formed 3.8 per cent of the total collection. In the adjoining area of Puri, Orissa State, PANIGRAHI (1942) found only 197 *Anopheles pallidus* (0.4 per cent) in 45134 specimens of 15 *Anopheles* species. In Sri Harikota *Anopheles pallidus* was only 0.5 per cent of total collection (RAGHAVAN & KRISHNAN, 1949) while in Terai area of Nainital District this mosquito formed 0.7 per cent (SRIVASTAVA, 1950). However VISWANATHAN *et al.* (1950) noted that in Thana District, Maharastra, *Anopheles pallidus* formed 8.3 per cent of total collection and in deltaic area of Bengal this *Anopheles* proved 23 per cent of total collection (JAFAR & IYANGAR, 1947).

The diurnal resting places seemed to be indoors in plains and outdoors in forest areas. VISWANATHAN *et al.* (1950) found 194 specimens of *Anopheles pallidus* from houses, 1112 from mixed dwellings and 293 from the cattlesheds of Thana District, Maharastra. REUBEN (1971) collected 21 specimens from cattleshed indoor resting. MISRA (1956) stated that this mosquito was taken in human dwellings in North-East Frontier Agency. However JOSHI *et al.* (1964) took no specimens from human dwellings while 4 specimens of *A. pallidus* were found outdoors from sites like tree holes and vegetation at the base of trees in Nepal during September/October 1963.

The pattern of feeding activities varied in different seasons. REUBEN (1971 a) noted that *Anopheles pallidus* peaked between 1900 and 2100 h after which activity fell off and then rose to a second peak between 2200 and 2400 h in the North Arcot District.

This mosquito appeared to be a perennial species in Bastar District however at six other places (Table 2) a variation in seasonal abundance may be seen. At Rupsa, Kharagpur, *Anopheles pallidus* had two peaks, one in rainy season while other in winter season. At Puri, Orissa, North Arcot in South India, and Udaipur, Madhya Pradesh, this *Anopheles* appeared to be a winter species. However in Nilgiris District, Madras Presidency and South Kanara this insect was noted as a rare species.

From human bait this species was not captured. However REUBEN (1971 a) took 41 and 3867 females of *A. pallidus* respectively on human and bullock baits in North Arcot District.

The precipitin analysis indicated an anthropophilic index of 3.7 per cent; however Senior WHITE (1947) found an anthropophilic index of 1.1 and 0.9 per cent in samples of *Anopheles pallidus* taken respectively from houses and cattlesheds. BRUCE-CHWATT *et al.* (1966) reported 13.6 per cent AI in 81 smears of *A. pallidus* from Ceylon taken from biotopes other than human and mixed habitations.

None of the female dissected had infection of sporozoites of malaria parasites. However ROY & BISWAS (1942) found 0.7 per cent sporozoite rate in 854 females of *Anopheles pallidus* dissected between August and November 1941 at Dharamjaigarh (Madhya Pradesh). Senior WHITE & ADHIKARI (1940) dissected 3157 females of *Anopheles pallidus* in Satpura Ranges

(Madhya Pradesh) and found 4 gut infections. In Bengal at four places (SUR & SUR, 1929; BOSE, 1931; TIMBRES, 1935; IYENGAR, 1939) and in Orissa at one place (Senior WHITE *et al.*, 1943) gut of salivary gland infection have been encountered. Despite these records *Anopheles pallidus* has not been considered as vector any where in India including Madhya Pradesh.

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ANNOUNCEMENTS

II CONFERENCE ON PARASITIC HYMENOPTERA

Gainesville, Florida

November 23—25, 1987

A conference on the taxonomy and biology of parasitic Hymenoptera will be held in Gainesville, Florida November 23—25, 1987 under the sponsorship for the University of Florida and the American Entomological Institute. Invited and contributed papers may be presented in the following sessions: Systematics, Biology, Biological Control, Techniques and Literature resources. Persons interested in participating and desiring further information may please contact Virendra Gupta at 3005 S. W. 56th Avenue, Gainesville, Florida 32608. Telephone (904) 392—9279. Registration form giving further details is under preparation.

NATIONAL SYMPOSIUM ON

Integrated Pest Control : Progress and Perspectives

A National Symposium on "Integraged Pest Control : Progress and Prespectives" is proposed to be organised some time in October 1987 at Trivandrum under the auspices of the Association for Advancement of Entomology. Details will be published in these columns in future issues, and may also be had from Prof. George Koshy, Convener of the Symposium, Department of Entomology, College of Agriculture, Vellayani-695 522, Trivandrum.

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